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## Forthcoming Events.

MARCH 8.

*British Foundrymen's Association (Birmingham Branch).*—Discussion on "The Practical Effect of Carbon on Iron as Viewed from the Equalibrum Curve of Iron-Carbon Alloys"; to be opened by G. Hailstone. Carnegie Research Scholar.

MARCH 14.

*British Foundrymen's Association (London Branch).*—Open Discussion on "Foundry Failures."

MARCH 15.

*British Foundrymen's Association (Halifax Branch).*—"Introduction to the Microstructure of Iron and Steel," by E. W. Smith, B.Sc.

MARCH 21.

*British Foundrymen's Association (Newcastle Branch).*—"Cupolas, their Construction and Working," by M. E. Gallon.

*British Foundrymen's Association (Scottish Branch).*—Annual Business and Open Discussion on Foundry Problems.

## NOTES AND COMMENTS.

### The Reaper.

During the past month there have been recorded the deaths of several prominent figures in the engineering world, some of them eminent examples of the self-made man. The life of Sir William Arrol, for example, is a striking comment on the possibilities of individual effort and force of character. He has been described as an engineer of genius, without one advantage to help that genius forword, except his Scottish resolution. He had little or no schooling and started life at twelve years of age in a cotton factory. From that he passed to the work of a blacksmith and engineer. Ten years later he was acting as foreman in the boiler and bridge yard of Messrs. Laidlaw & Company, of Glasgow, and at the age of twenty-nine he set up on his own account with capital saved from his wages. Success followed success, and before he was forty he obtained the contract for the building of the famous Forth Bridge. Then, following the disaster to the Tay Bridge, he was chosen to construct the viaduct that now connects Edinburgh and Dundee. On the day of the opening of the Forth Bridge he was knighted. The Tower Bridge and the Manchester Ship Canal were also both his work. The achievements named would alone have constituted a remarkable record for a self-made man, apart from his other work.

A few days prior to the death of Sir William Arrol was recorded the passing of America's oldest, and one of its greatest engineers, John Fritz, at the age of 91. The name of Fritz will be remembered with gratitude and admiration by the whole profession of American mechanical, metallurgical and mining engineers which he so long adorned. John Fritz was of German stock. His father, George Fritzius, who was a farmer, was born near Cassel, and emigrated with his parents to the United States at the age of twelve, but he developed a very unusual genius for mechanical engineering. John, the eldest son, soon broke loose from the farming life, and learned the trade of a blacksmith. He became foreman at a blast furnace, of the type in use in the year 1840, and later entered a rolling mill as machinist. Contriving tools and expediencies when no teachers and no precedents were available, he worked by day at his trade, and spent the evening hours learning puddling as a volunteer. For his efforts he was made night superintendent of the Norristown Iron Works, and was then offered the superintendency of a new plant in the Susquehanna Valley. Later he left to start engineering works on a small scale on his own account, and with him were associated four men, all of whom afterwards made for themselves names as great engineers. The enterprise not proving as profitable as he wished, he accepted in 1854 a position as technical head of the Cambria Iron Company, in Johnstown, Pa. The years he spent in this place were full of remarkable achievement. He took charge of a

poorly built and antiquated plant, and was expected to make a success. There was no money available, and the monthly wage bill had often to be paid in paper scrip or promissory notes. A fire devastated the rolling mill department; everything required for restarting had to be made at home. John Fritz, with his indomitable will and remarkable resource, overcame all difficulties. He invented and installed the first three-high rolling mill, and left the Company strongly established on the high road to the success later achieved. In 1860 he transferred his activities to the Bethlehem Iron Company, with which newly-formed concern he remained during his entire active life. He saw this enterprise grow from a couple of puddling furnaces and a small rolling mill to become one of the large plants of the world. He constructed blast furnaces for the use of anthracite coal, and equipped them in a manner far in advance of his time. He introduced the Bessemer process, inventing auxiliary machinery for the same, and brought it to such perfection that his output was about double that of the best similar plants in Europe. In 1885, when the defensive power of the United States was at its lowest, it was John Fritz who conceived the necessity for the construction of a gun and armour-plate plant. He made the necessary arrangements with French and British works for the use of their experience and machinery, and then built the magnificent installation which produced all the armour and all the heavy guns which for many years were used in the United States navy and army.

Among other honours, Fritz received the Bessemer Gold Medal, was elected Honorary Vice-President of the Iron and Steel Institute, honorary member of the Verein Deutscher Eisenhüttenleute, and had conferred on him the honorary degree of Doctor of Philosophy. He acted as President of the American Institute of Mining Engineers, and of the American Society of Mechanical Engineers. In 1902 a fund was raised instituting the John Fritz Gold Medal, to be yearly presented as the highest distinction that can be conferred by the American engineering societies, for achievements within their sphere. He himself was the first recipient of this medal. At the age of 88 he carried out his last piece of engineering work, this time for himself. It was the Fritz mechanical testing laboratory, which he, at his own expense, constructed and presented to the Lehigh University, in South Bethlehem, Pa.

One other notable career which has just been closed by death may be mentioned—that of Sir William H. White, the distinguished naval architect. Sir William Henry White, K.C.B., Hon. LL.D., D.Sc., F.R.S., was born in 1845, and, except for a brief period in the early eighties, served the Admiralty from his entrance into Devonport Dockyard as a shipbuilder's apprentice, in 1859, till 1902. From 1885 to 1902 he was Assistant Controller of the Navy and Director of Naval Construction, and during the time he was in full control he was responsible for the designs of 245 ships, on which there was a total outlay of over one hundred millions sterling. During his service he witnessed practically the whole evolution of the battleship from thethree-decker to the Dreadnought. At the age of fourteen he entered the dockyard, by competitive examination, and he has confessed that his career was built up on a series of competitive examinations. His earliest ambition was literary; but being in a dockyard, he turned his attention to ships, and in due course won a place in the Royal School of Naval Architecture, Devonport, eventually taking the diploma of Fellow of the school in the first class. At the age of 22 he had gained a good position in the Constructive Department of the Admiralty.

In 1870 William White was appointed a professor at the Royal School of Naval Architecture, and in 1883 he left the public service and went to Armstrong & Company, on the Tyne. But he was back again at Whitehall in 1885, and in full charge of the construction department. He then began his historic work of making the British fleet as we know it. The vessels of his design were never subjected to the test of war, except two protected cruisers of the Japanese navy, built at Elswick, but they all have been excellent sea boats. After leaving the Admiralty finally, Sir William White became intimately concerned with the plans for the "Mauretania."

**Industrial Training.**

The discussions on this subject do not appear to lessen in force, either as regards the opposition to an organised and national system of industrial training or the conviction with which the claims for that system are put forward. This is evidenced by the Paper on the subject presented before the Sheffield Branch of the British Foundrymen's Association on February 14, by Mr. J. W. Horne. We do not at the moment propose to discuss the points raised, but it is interesting to note in connection with some of the suggestions put forward, that the Irish Technical Instruction Department, founded by Sir Horace Plunkett, has now introduced a system which provides for the training of boys in trade preparatory schools until the age of 16 years. They are then to avail themselves of scholarships, which will carry a lad through the whole course of apprenticeship and trade. If the wages he receives from his employer are less than 15s. a week, the department undertake to pay him the balance, and in certain cases the department will provide part of the indenture fee when required. This system is undoubtedly worthy of the careful consideration of employers and local education authorities in England. At present too many lads leave school with no trade prospects at all. Employment bureaus may do something to alleviate this evil, but they are not empowered, and possess no funds, for such work in the way of promoting apprenticeship as the Irish Board has begun.

There are many, of course, who will condemn this fostering of the apprenticeship system as being bad economics, on grounds both varied and contradictory. In fact, it is quite a common line of objection to any such suggested scheme that "the economic side of the subject has not been taken into consideration." Surely to prove that a certain end is desirable in the interests of the community is to go right to the heart of the economic side of the subject. The exact method of attaining efficiency in industrial operations may be open to discussion and dispute, but so long as the end is kept in view the economic aspect is essentially dominant. The fact is that frequently the requirements of an individual's, or a single firm's, so-called economics (better termed their system of operation), conflict with the basis principles when the latter come to be applied, and because of that it is claimed that the economic side of the subject is not receiving attention. Because a suggestion is not clothed in the language of the politico-economist's text-book, it does not follow that the economic side is being neglected. Nor is it correct to assume that any desirable scheme is bad economics—the suggestion is absurd if the ultimate end is desirable. What is economics but the science of correctly applying resources and wealth for a desirable end? How then can one be said to ignore the economic side when the method of attaining that end is discussed. The fact that details as affecting certain established ideas and institutions are not discussed at the moment does not rule the suggestions out of the realm of economics.

# Specifications for Foundry Pig-Irons.

By W. B. Parker, F.I.C.

At a meeting of the Birmingham Branch of the British Foundrymen's Association, held on January 20, at Birmingham, Mr. W. B. Parker, F.I.C., presented a Paper on "Specifications for Foundry Pig-irons (Part II.)." An invitation to attend had been given to the Birmingham Metallurgical Society. Mr. R. Buchanan presided. In the notice convening the meeting, there was a reference to Part I. of the Paper, which was read in May, 1906, and particulars of which were published in the "Foundry Trades Journal," June 1906. The lecturer said :—

This Paper deals with the pig-irons utilised in iron foundries, in contradistinction to those used in steel and malleable cast-iron foundries. It is further limited to a consideration of the requirements of the British Isles alone.

As pointed out in the first Paper, the matter must be dealt with as a national question, and it is still the opinion of the speaker that a single satisfactory international standard embracing all pig-making countries will never be possible of realisation. Nevertheless, it is perfectly feasible and highly necessary that each nation should standardise its own products, and also set out the system it prefers for the guidance of other countries who desire to export their products to them.

One of the best of the early attempts to grapple with pig-iron specifications is that of Mr. W. H. Pretty, A.M.I.C.E., of Bedford, which is given in his Paper, "The Economic Value of Cast Iron," read before the Manchester Association of Engineers, December, 1904. The system therein given is incomplete, as will be shown later. Mr. Pretty states that :—"It would be far better to grade these irons by analysis, even if only approximately correct. Such a system of classification would at once enable pig-irons of various brands to be compared with reasonable accuracy." He further states :—"It may be urged that the fracture of the pig is a sufficient guide, but this is not so, except perhaps in the case where we are dealing with the same product, produced at the same furnace, cast under similar conditions of temperature, etc., etc., *and even then it takes an experienced man who has a full knowledge of the material he is dealing with.*"*

From these quotations it will be seen that Mr. Pretty was apparently chiefly intent upon comparing various individual brands of pig-iron, for instance, Ulverston hematite with Seaton Carew hematite, and was not interested in the actual standardisation of the practice of grading the pig-irons of each iron-producing district individually, or in groups. He obtained from manufacturers typical analyses of their brands and grades, and drew curves expressing these. He aptly terms these curves the "Brand Characteristics." He states :—"Each brand characteristic, as the name implies, deals with one production only . . . . . the results from any one furnace . . . . . are of a remarkably uniform nature."

He thus *standardised the grades of the individual brands*, but did not systematise the various brands collectively as a whole. His characteristic curves are in most cases quite correct.

Now, the above Paper was of great interest to myself, for on August 11, 1904, just four months prior to its publication, I had instituted a set of specifications which covered the first three or four grades of the pig-irons typical of the four main iron-producing districts of Great Britain, which together with a letter commenting upon their introduction into use for buying, was intended to regulate the purchasing of pig-iron for the firm with whom I am connected. These specifications were at once put into use for inquiries, and were briefly reviewed, with excerpts from the commentary letter, in the IRON AND COAL TRADES REVIEW, of September 23, 1904, and the FOUNDRY TRADE JOURNAL, of September 18, 1904.

I believe the above specifications to be the very first approximation to any complete system of pig-iron specifications which aims to be applicable to the British industry as a whole. The idea underlying them was developed and communicated to this Association in 1906. To-night we reach the next stage, and hand round for your perusal, and use, copies of the completed and revised specifications.

With respect to the use of these specifications, I may say that the makers' replies resulting from the application of the early draft specifications in 1904 were on the whole satisfactory, in spite of the well-known prejudice of the iron trade to innovations. What is now required is to draw in as many users as possible to try the Revised Specifications, and to thus bring pressure upon the pig-iron makers to come into the arena; for everybody recognises that only by a combination of effort of both makers and users can they be finally settled as National Standards.

Personally, I have every confidence in the feasibility of these specifications, but there remains to be overcome a good deal of inertia in the trade, so that users must not blame the Specifications if they find they have to "roll up their sleeves and fight a bit" in order to get them accepted as a working basis. The early replies, of course, caused modifications in some of the limits, but in no instance did we receive a statement to the effect that the Specifications were fundamentally wrong or impossible from the view of commercial production. In fact, the impression left is that the opposition is more of a personal character, and this will be dealt with presently.

My aim had been to show that in spite of the possible exhaustion of local ore supplies, also variations in blast-furnace practice due to its natural growth and improvement, and the modern specialised demands of pig-iron users, yet the irons made in our chief blast-furnace districts still remain almost the same as in 1880, or even 1875. That is, they have remained very characteristic of their respective localities. Of course, it will always be greatly to the advantage of pig-iron makers to keep this so, and it is of importance to embody this as far as possible in the Specifications. This has been done.

It is the practical impossibility of entirely removing such differences which renders impossible the evolution of a single International Standard. Such differences are of great practical value, and the British iron-foundry trade would be at a serious disadvantage if they ceased to exist. By judicious use of them, we are able to lead the world in any combination of quality and price of castings.

Having satisfied myself that the above was really the case, I saw immediately that it very much

* These portions are italicised by the present writer to give point to subsequent comments.

simplified the question of British specifications for foundry pig-irons, since it chiefly necessitated the standardisation of the grades or numbers for each district. The rest of the specification for each locality almost looks after itself, though, of course, limits must be set for the items it includes.

### Grading.

The question of grading was, however, a very difficult one to clear up because of local customs or methods, and also the fact that the purchase of foundry pig-iron to analysis had only of recent years been broached, and so there was lack of unanimity on the part of buyers regarding what should be taken for the basis of the grades, *i.e.*, whether silicon, combined carbon, or sulphur. The latter was suggested by Mr. P. Munnock in August, 1906, but he has since admitted he was on the wrong track. Silicon has by far the most advocates, both in Britain, America and on the Continent.

In all systems the upper, first, softest and most costly grade is called "No. 1 Grey," and it is invariably richer in silicon than grades 2, 3, 4, 5, Forge, Mottled and White. Silicon is therefore a rational basis, but is not sufficient in itself.

### Grading by Fracture.

With regard to grading by fracture, Mr. Pretty's remarks are perfectly correct, for as every one who has straightforwardly studied the subject knows, this method is not sufficiently reliable for modern foundry practice.

Users of pig-iron which is graded by fracture have a perfect right to ask whether the makers of the iron can truthfully claim that they only employ for their grading, *experienced men who have a full knowledge of the material they deal with*. The fact is that generally speaking this claim, whether positively made or merely implied, is not lived up to. The men employed for grading by fracture are almost invariably labourers, pure and simple. Labourers cannot possibly possess the requisite knowledge; they are not supplied with the necessary data, and know next to nothing of the laws governing the character and metallurgical value of the material. Therefore for present-day manufacturers to maintain in opposition to the chemical methods, a system of fracture grading conducted by unskilled workers, who frequently possess marked personal predilections which influence the results, is from a common-sense and commercial point of view utterly preposterous.

TABLE I.—*Variations in Fractures without Corresponding Variation in Analyses, Illustrated by Three Pigs from the same Truck Group II, Class X. Pig-iron*

| | T.C. Per cent. | G.C Per cent. | C.C. Per cent. | Si. Per cent. | P. Per cent. | S. Per cent. | Mn. Per cent. |
|---|---|---|---|---|---|---|---|
| Open grain .. .. | 2.88 | 2.88 | Trace | 3.87 | 1.70 | 0.03 | 0.35 |
| Medium grain .. | 2.80 | 2.80 | „ | 3.60 | 1.67 | 0.03 | 0.35 |
| Close grain .. .. | 2.82 | 2.82 | „ | 3.74 | 1.68 | 0.04 | 0.33 |

### Grading by Combined Carbon and Silicon.

My system of grading is mainly based upon the combined carbon, but this is worked in conjunction with the silicon. It was pointed out in the first Paper (1906) that the combined carbon is the true basis of grades, and the advantages of the "Combined Carbon and Silicon" system is there fully explained.

It was shown that the silicon in the different grades of a carefully graded set of samples of any one brand of pig may vary from 0.10 per cent. to 5.0 per cent., but that the total carbon is rarely below 2.75 per cent., or over 4.0 per cent., while the combined carbon varies from traces up to 4 per cent.; the two variables are therefore silicon and combined carbon. Since the year mentioned there have been several Papers confirming this by statement or natural inferences. One of the latest and most interesting is a Paper by Herr J. Kail (manager of Ganz & Company), of Buda-Pest, read at the New York Congress of the International Association for Testing Materials, 1912. Herr Kail clearly shows that :—

(1) The character or class of graphite present, also the segregation of the graphite, and the size of the graphite plates are the real factors of the *visual differences* of the fractured surfaces of pig-irons.

(2) The total carbon varies so little that it is not the important factor in reference to fractures.

(3) Silicon is the only element which varies in sufficient percentages to influence the appearance of fractures to such an extent that the grade can be inferred from it.*

It was also shown :—

(4) That even with silicon the estimation is unreliable, since other factors such as casting temperatures and rate of cooling also make such differences on the relative size of the graphite plates and degree of their segregation and other features mentioned above, that the grading estimated by appearance of the fracture very often is wholly misleading from the foundry point of view.

In other words, the true grading of a pig-iron *is* dependent upon its *quantitative composition* as regards combined carbon and silicon, and is *not* dependent upon the *quantitative appearance* of the graphite shown by its fracture. The quantitative composition as regards combined carbon and silicon can only be determined by chemical analysis; therefore grading by analysis is absolutely essential for correct grading.

### System of Specifications.

The writer's Paper of May, 1906, dealt fairly fully with all pig-irons except those classified as Group I. Special. As the latter are not used to so great an extent, first hand experience with them takes longer to accumulate. The complete grading of Group I. is given here, so that there are now four entire groups, namely :—

*Group I.—Special pig-irons*, which is sub-divided into—

*Class A*, which includes all genuine all-mine cold-blast pig-irons made with coke or coal as fuel, and a temperature of blast not over 200 deg. F.

*Class B.*, which includes all genuine all-mine pure hematite charcoal pig-irons, made with cold-blast (temperature not over 200 deg. F.) or semi-cold blast (temperature between 200 deg. F. and 600 deg. F.).

*Class C.*, which includes all genuine all-mine coke or coal smelted pig-irons, made with semi-cold blast (200 deg. F. to 600 deg. F.), or hot blast (600 deg. F. to 1,000 deg.F.).

*Group II.—English Foundry Pig-irons*, which is sub-divided into—

*Class X*, characterised by comparatively low manganese.

*Class Y*, characterised by comparatively high manganese.

*Group III.—Scotch Foundry Pig-irons*, which are

* But as is well known, the silicon, if below 3.75 per cent., always acts entirely indirectly, i.e., by its effects upon the melting point of the metal and the solubility of the carbon in the iron.

characterised by a combination of high manganese, and only moderately high phosphorus.

*Group IV.—Hematite Foundry Pig-irons*, which is further sub-divided into—

*East Coast Hematites*, characterised by comparatively high manganese.

*West Coast Hematites*, characterised by comparatively low manganese.

The specifications herewith presented have been extended to include all grades and also contain modifications of certain limits published earlier. The chief modifications found necessary since 1906 consists of :—(1) The division of the early Grade No. 1 into two grades, called Extra No. 1 Grade, and Ordinary No. 1 Grade, or more shortly No. 1 Grade.

We found that except in the case of Group I. (special pig-irons), more and more high-silicon pig-iron is being produced which is sold at reasonable prices, and is usually well below the specified limits for sulphur; consequently it has an increasing sale because it will carry large amounts of very miscellaneous scrap. This metal is often described by makers as "silky," or "silicious." It is evidently a somewhat modern extension of existing grading, and therefore needed standardisation. This is done by making the Extra No. 1 Grade of Groups II., III., and IV., which specify :—Maximum silicon, 5.0 per cent.; standard silicon, 4.0 per cent.; minimum silicon, 3.75 per cent.

It is interesting to note that out of 160 truck loads of this metal received in 1912 from various makers, but all ordered to Group II., Class *X*, not one came outside limits, and the average was 4.2 per cent. silicon. Upon reference to American blast-furnace practice, it will be found they have had such a grade in use for some considerable time. Speaking from personal observation, I feel there is a distinct tendency throughout our foundry business to drop Grade II. as a definite demand, and to use Grades Extra No. 1, Ordinary No. 1 and No. 3, etc. This is because it is more convenient and cheaper to make metal corresponding to Grade II. by melting the other numbers in the cupola than to buy it at the furnaces. However, to make the scheme of specifications complete, Grade II. was retained.

In actual practice, as one goes from No. 3 to 5, or Forge grades, it is found that fracture grading gets somewhat more indicative of composition by reason of the more pronounced effect of the combined carbon contents (also the increasing influence of sulphur) upon general appearance. Similarly, in Grades Nos. 1 to 3, the "over-lapping" of the silicon permitted is highest, and as we pass to Nos. 4, 5 and Forge grades, the necessity for it becomes less, and consequently the silicon limits are somewhat modified to meet this fact.

It is obvious that it is when at the extremes of the gamut of grades or silicon contents that most care has to be taken in actual use of the metal in a mixture. Therefore absolute consistency throughout is not claimed with respect to the over-lapping arranged for the grades of any particular group. What is specified is mainly based upon practical experience and a consideration of the demands of a very wide range of businesses. Suggestions upon this point will be very welcome, since as many special demands should be considered as possible.

The second important modification is the phosphorus limit for Group II., Classes *X* and *Y*. After some twelve years' experience, my conclusion is that the practical uses to which this group of pig-iron is put do not demand the earlier 1.5 per cent. maximum limit sufficiently often to warrant its retention in preference to the more liberal maximum of 1.75 per cent. Even this generous limit is occasionally exceeded, but when it is, the delivery should be only accepted if subject to a reduction in price. The extension of the system to Forge, Mottled and White grades required considerable time, for it was necessary to carefully consider the limits for sulphur and to ascertain whether for foundry purposes it is really necessary to retain as two distinct grades, the Mottled and White qualities.

The decisions arrived at are that for foundry uses the sulphur must be under 0.25 per cent., especially in the low-manganese irons of Group II., Class *X*, and Group IV., West Coast hematite. Also that there is really no very definite advantage to be gained in grading the Mottled and White as two distinct grades in the Groups II., III., IV. But that, in the case of Group I. (special irons) there is need for this more detailed differentiation between Mottled and White because they are required for special work, such as chilled castings, and further, the prices paid for such metal warrants a more complete grading. Consequently Mottled and White are treated as one grade in all cases except Group I.

In the case of sulphur it is unfortunately a fact that it is somewhat difficult to persuade makers to exercise the necessary care in their furnace practice, and to select and pay the slightly higher price for coke sufficiently low in sulphur to produce mottled to white pig-iron containing not over 0.25 per cent. sulphur. The hematite pig-iron makers are big sinners in this matter, in spite of the fact that they start with pure ores. With this great natural advantage there appears no justification for this state of things in the hematite pig-iron trade. One of their own experts writing about ore mixing, states that "while as regards the sulphur (in ores), although it should be as low as possible, this is not a *sine quâ non*, since it may be removed by suitable fluxing (a high sulphur content in the burden means more flux and fuel)."

This being so, surely the users of hematite iron have a right to fix reasonable limits, though, of course, the above statement by Mr. J. James Morgan, F.I.C., may need slightly qualifying when referred to mottled and white iron, generally because of the lower temperatures and acid slags necessary for their production. It is clear, however, that it is possible to exercise considerable control over the sulphur, and the remedy is a more careful selection of the ores, flux, and *especially the fuel*, accompanied by scientific control of the temperature and volume of the blast, etc.

It is, for instance, absurd to use cokes like that shown in Table II., yet they are genuine analyses of fuel sold in the Sheffield district for this purpose.

TABLE II.—*Samples of Inferior Furnace Coke.*

| Ash. Per cent. | Sulphur. Per cent. |
|---|---|
| 13.10 | 1.60 |
| 14.98 | 0.89 |
| 16.20 | 1.02 |
| 14.40 | 1.30 |
| 14.60 | 1.15 |
| 15.50 | 1.23 |
| 12.40 | 1.37 |
| 14.80 | 1.70 |

People who nowadays sell such miserable fuel for metallurgical purposes ought to have their product penalised in price.

### Combined Carbon.

Limits for combined carbon have been inserted for each grade of Group I. and Group II. (Classes *X* and *Y*), but only for the more commonly used grades of Group III. and Group IV.

It is apparent from the samples so far met with that the limits for the remaining grades will be similar to those issued, but we prefer to defer inserting them until further first-hand experience

has been accumulated. Suggestions upon this matter are invited.

In actual practice it is found the combined carbon of Grades I., II., and III. of Group II., *X* and *Y*, very seldom reaches the maximum allowed. That is, the pig-iron corresponding to the silicon contents of these grades is, more often than otherwise, on the soft side. Yet it is certainly necessary to retain the specified limits for combined carbon, as these irregular results are undoubtedly due to pecularities in the methods of casting and cooling the pig-iron. Most probably because the pigs are covered with much sand immediately after casting. Variations of simple matters like this help to cause fracture-grading to be so unreliable.

The following differences exist between my grade names and those commonly reported as in use in Cleveland :—

TABLE III.—*Comparison of Grade Nomenclature.*

| Author's. | Cleveland. |
|---|---|
| Extra No. 1 | Silky or siliceous. |
| Ordinary No. 1 | No. 1. |
| No. 2 | No. 2. |
| No. 3 | No. 3. |
| No. 4 | No. 4 Foundry. |
| No. 5 | No. 4 Forge. |
| Forge | No equivalent. |
| Mottled to White | Mottled. White. |

If there is need for any curtailment of the number of grades, I would suggest Grade No. 2 be eliminated, for this would not entail alterations in the silicon limits for Ordinary No. 1 and No. 3—it merely removes any over-lapping of the adjacent grades and appears to be a natural line of development. It will be noticed that I give a distinct number, viz., No. 5, to the fifth grade in preference to the term "No. 4 Forge;" it is more logical and less likely to cause confusion in ordering and stacking the material.

### Sampling.

Although the method of sampling proposed in Part I. of this Paper has been critically assailed by Mr. Hailstone, yet from practical comparisons of it with his and other proposed methods, I still prefer my own, and see no urgent need to revise it. It has one marked advantage over Mr. Hailstone's, namely, that it gives the analysis of the actual fractured surface as well as the pig taken as a whole. This permits of a much closer and more positive comparison and correlation of fractures with analysis.

The results obtained naturally led me to the discovery of the generalities underlying the specifications being discussed. I much doubt if any other system of sampling would have led to these so promptly.

To illustrate the uses of the system may be shown illustrations of fractures, together with their ordinary chemical analysis, and what can be termed their "rational analysis." The latter aims at determining the percentage by weight (not volume) of the microchemical constituents—such as manganese sulphide, free ferrite, cementite, free phosphide of iron, etc. The data is not quite complete, as it is only part of an investigation being carried out by my chief metallurgical assistant (Mr. J. H. Robinson) and myself, which aims at correlating the fractures, ordinary analysis, rational analysis, microstructure and physical tests of the different classes of pig-iron. The analyses are Mr. Robinson's work, and were made with all possible care. (See fracture photographs and Table VI., pages 151, 152 and 153.)

In conclusion of this heading, I would like to say that two firms of Scotch pig-iron makers issue booklets containing excellent photos of fractures of their pig-iron, together with their approximate analyses. This is a step in the right direction, and ... makers will do the same, a much better understanding between sellers and buyers will result; but on the other hand it is no good firms issuing photos and then inscribing underneath the legend "Silicon as required." One English firm has done this, and I always feel tempted to cut out their photo of a nearly white-iron fracture, and ask them to send 10 tons to that fracture with 4 to 5 per cent. silicon—it might cure them of such nonsensical advertisements.

We now turn to the newer part of this Paper, namely, the classification and grading of Group I., special pig-irons. First we must arrive at reasonable definitions of the terms used for distinguishing these special pigs, namely:—Cold-blast; semi-cold blast; hot-blast; and super-heated blast.

### Blast Temperatures.

After considerable investigation, the following were decided upon as most suitable for standardisation :—

TABLE IV.—*Nomenclature of Blast Temperatures.*

| Description. | "Standard Temperatures." Range of Temperatures. Degrees Fahr. |
|---|---|
| Cold blast | Between 60 and 200 |
| Semi-cold blast | „ 200 and 600. |
| Hot blast | „ 600 and 1,000. |
| Super-heated blast | „ 1,000 and 2,000. |

These temperatures are not very different from those quoted by Mr. West as recognised in American practice. But if almost any British text-book be consulted, the lack of definite statements upon these commonly-used terms will be astonishing. Heaps of instances of blast temperatures are quoted, but even prominent authorities appear to shirk defining the exact temperature corresponding to each term.

The necessity of standard definitions is self-apparent. Once decided and practically adopted, they would remove a great many misrepresentations, and would give general confidence, which would result in increased sales and more straightforward prices. The definitions are quite independent of the fuel employed, blast pressures, volume of blast and other controversial details. This would still leave ample latitude for initiative in manufacture and furnace design, and variation in strength, purity and other features of the products; but it would insure an honest understanding as to the significance of the descriptions when applied to any brand.

### Fuel.

Buyers also have a perfect right to a guarantee that the fuel used is as described by the sellers or manufacturers, *i.e.*, a charcoal pig should honestly be smelted with charcoal, and so on.

### Ore Burdens.

The terms "All-mine," "Part-mine," and "Cinder pig" are more clearly understood generally, but nevertheless, these terms should be clearly defined and the definitions standardised and honestly adhered to for working purposes.

### Description of Ores Used.

When manufacturers sell pig-iron under a description of the ore used, such as "Hematites," I believe the buyer has a Common-Law right to insist upon the actual ore used complying with the manufacturer's

description. But it does not usually concern the buyer as to the exact source of the ore, hematite, or otherwise, unless some special statement is made by the maker respecting the "charges" he uses, for which he demands a special price, and intimates he is giving special value and properties in the pig sold. In the latter case it is also very probable the buyer again has a Common-Law right to insist upon the maker complying with his description.

The same remarks apply to pig-iron which is described by its sellers as being manufactured in any particular locality. These descriptions should be honest ones—*i.e.*, Swedish pig must come from Sweden, Chilian from Chili, Scotch from Scotland, and Austrian from Austria, and so on.

### Refined Pig-Irons.

The speaker believes some of the brands described as refined pig-irons are "fakes"—*i.e.*, mixtures of pig-iron, cast iron and steel scrap. In the metallurgy of iron there is only one commonly accepted interpretation of the term, "refined pig-iron," and this definitely refers to pig-iron which has been purified by the old Lancashire hearth or refinery process. This is a process of "scorification" by an oxidising blast and acid slag. This process is so expensive that it seems hardly feasible that any of the so-called refined pig-irons can honestly claim production by its employment. Their composition often will not agree with that of the products of this process.

At the present time there is, of course, the possibility of refining pig-iron by electrical furnaces, or by a combination of one of the ordinary steel furnaces with an electrical furnace. It appears somewhat improbable such methods would allow their products to sell at as low as £5 10s. to £6 17s. 6d. per ton delivered in the Midlands, unless fuel and electrical power were obtainable at very exceptionally low cost. Consequently the description "refined pig-iron," when applied to modern products needs definition and standardisation, and because of the uncertainty mentioned, I have omitted all "refined pig-irons" from classification.

Similarly, basic pig-irons which are sold under such terms as "special cylinder irons," are omitted, additional reasons being that true basic pig is a steel-maker's pig-iron, and on the whole is not sufficiently different in composition and real value from Group II., class Y pig-irons, to warrant special classification.

The above will be of assistance in following the grading, etc., of Group I. special pig-irons. I only need to add that the grading of Group I., Class *B*, runs very closely to actual Swedish grading, which, using descriptions of fractures, is approximately as follows :—

TABLE V.—*Silicon Contents of Swedish Pig-iron Grades.*

| Makers' description | Observed Silicon Limits. Per cent. |
|---|---|
| Grey .. .. .. .. .. | 1.0 to 3.0. |
| Edge White .. .. .. .. | 0.75 to 1.4. |
| Half White .. .. .. .. | 0.4 to 0.75. |
| Mottled (Shot or Spotted) .. .. | 0.25 to 0.5. |
| Entire White .. .. .. .. | 0.10 to 0.5. |

The average temperatures used for producing Class *C* pig-irons is between 200 deg. F. and 600 deg. F., but some furnaces reach 900 deg. F., though they usually produce the impurer brands.

### Objections to the Use of Specifications.

The following comments are not intended to be personal, and have been added with the sole object of reviewing the very dilatory attitude of British pig-iron makers and users towards the subject under consideration.

Reviewing the last six years' experiences, there appear certain kinks in the trade which need notice, for the purpose of eradication, and in order to speed up the introduction of specifications. For instance, some producers and salesmen appear to oppose standardisation of grades for no nobler reason than that by continuing grading according to their own fancy in fractures, they are at times able to get, say, a No. 1 grade price for a No. 4 grade pig. Others, when in competition with another maker selling, say, a No. 1 grade containing 3.5 per cent. silicon (which is standard) will say to the prospective customer: "I can beat that rival brand in price and in strength." Now the way they usually "beat it" is to sell a lower grade iron, containing, say, 2.75 per cent. silicon, which by some cause (most probably the rate of cooling on the pig-bed) happens to possess a similar appearance of fracture to their competitor's genuine No. 1 grade pig. Hence they hoodwink their customer, by taking, say, 1s. per ton less, and outsell their rival. The cheaper iron is naturally somewhat stronger by reason of its lower silicon contents, but it would not fetch the price charged, if sold on its true grading and merits.

Some producers have got into the habit of systematically making and grading their product in such a way that it is often saleable in this questionable manner. Then again, some makers claim special features for their metal, which they infer cannot be standardised—such as extra-high manganese, low sulphur or phosphorus, extra density, and so forth. These claims in some cases are supported with analytical reports as ancient as the pyramids, and about equally useful to those foundrymen who are foolish enough to accept them as gospel and work to them.

In many cases it is not the makers but the selling agents who oppose specifications, but this can frequently be overcome by purchasing, whenever possible, direct from the makers. In some cases opposition is due to owners objecting to employ the necessary chemical staff to do the grading by analysis. Other owners or managers say they dread the analytical method because it might lead to quibbling over analytical results. Also they fear that should the market turn against their customer and in their own favour, the former might, by rejections of material over paltry analytical differences, get out of his contracts.

The speaker thinks that a sales manager who cannot draw up a Contract of Sale, which will stop "paltry analytical differences" from preventing its "just completion," is fully ripe for replacement by a better man, of which there would be many available.

In occasional cases the fault is due to the chemist employed being of an unsatisfactory type, possessing neither sufficient scientific knowledge, business acumen, nor force of personal character to win and fill the position with regard to the whole management of the process, which should, for many good metallurgical and common-sense business reasons, be possessed by all blast-furnace chemists. If both makers and buyers will employ as chief chemists *bona-fide* diplomaed members of the chemical profession, who combine works' experience and a college, or equivalent technical high-school, training, the latter arguments for opposition to pig-iron specifications are eliminated.

It has been repeatedly demonstrated that with an efficient chemical staff, it is quite possible to analytically grade the whole output of a modern blast furnace each day, at very small cost and with perfect accuracy, the results being satisfied customers and bigger profits to the manufacturers.

# Specifications for Foundry Pig-Iron.

### Special Foundry Pig Irons : Group I. Class A.

*Includes all Genuine "All-mine" Cold Blast Pig Irons made with Coke or Coal as Fuel and a Temperature of Blast not above 200 deg. F.*

**Grade Number I.**

| | |
|---|---|
| Combined Carbon, not under | 0.4% |
| Silicon, Maximum | 2.5% |
| „ Standard | 1.75% |
| „ Minimum | 1.50% |
| IMPURITIES. | |
| Phosphorus, not to exceed | 0.70% |
| Sulphur, not to exceed | 0.05% |
| Manganese, not to be under | 0.25% |

**Grade Number II.**

| | |
|---|---|
| Combined Carbon, not under | 0.5% |
| Silicon, Maximum | 1.75% |
| „ Standard | 1.50% |
| „ Minimum | 1.25% |
| IMPURITIES. | |
| Phosphorus, not to exceed | 0.60% |
| Sulphur, not to exceed | 0.05% |
| Manganese, not to be under | 0.25% |

**Grade Number III.**

| | |
|---|---|
| Combined Carbon, not under | 0.6% |
| Silicon, Maximum | 1.25% |
| „ Standard | 1.00% |
| „ Minimum | 0.75% |
| IMPURITIES. | |
| Phosphorus, not to exceed | 0.60% |
| Sulphur, not to exceed | 0.06% |
| Manganese, not to be under | 0.25% |

**Grade Number IV.**

| | |
|---|---|
| Combined Carbon, not under | 0.75% |
| Silicon, Maximum | 1.00% |
| „ Standard | 0.75% |
| „ Minimum | 0.50% |
| IMPURITIES. | |
| Phosphorus, not to exceed | 0.50% |
| Sulphur, not to exceed | 0.08% |
| Manganese, not to be under | 0.25% |

**Mottled.**

| | |
|---|---|
| Combined Carbon, not under | 1.00% |
| Silicon, Maximum | 0.75% |
| „ Standard | 0.50% |
| „ Minimum | 0.25% |
| IMPURITIES. | |
| Phosphorus, not to exceed | 0.50% |
| Sulphur, not to exceed | 0.10% |
| Manganese, not to be under | 0.25% |

**White.**

All Carbon to be in combined condition.

| | |
|---|---|
| Silicon, Maximum | 0.50% |
| „ Minimum | 0.10% |
| IMPURITIES. | |
| Phosphorus, not to exceed | 0.50% |
| Sulphur, not to exceed | 0.15% |
| Manganese, not to be under | 0.25% |

### Special Foundry Pig-Irons : Group I. Class B.

*Includes all Genuine "All-mine," pure Hematite, Charcoal Pig Irons, made with Cold Blast (temperature not over 200 deg. F.) or Semi-Cold Blast (temperature between 200 deg. F. and 600 deg. F.)*

**Grade Number I.**

| | |
|---|---|
| Combined Carbon, not under | 0.3% |
| Silicon, Maximum | 3.0% |
| „ Standard | 2.5% |
| „ Minimum | 2.0% |
| IMPURITIES. | |
| Phosphorus, not to exceed | 0.05% |
| Sulphur, not to exceed | 0.05% |
| Manganese, not to be under | 0.25% |

**Grade Number II.**

| | |
|---|---|
| Combined Carbon, not under | 0.8% |
| Silicon, Maximum | 3.0% |
| „ Standard | 1.5% |
| „ Minimum | 1.25% |
| IMPURITIES. | |
| Phosphorus, not to exceed | 0.05% |
| Sulphur, not to exceed | 0.05% |
| Manganese, not to be under | 0.25% |

**Grade Number III.**

| | |
|---|---|
| Combined Carbon, not under | 1.5% |
| Silicon, Maximum | 1.25% |
| „ Standard | 0.75% |
| „ Minimum | 0.50% |
| IMPURITIES. | |
| Phosphorus, not to exceed | 0.05% |
| Sulphur, not to exceed | 0.05% |
| Manganese, not to be under | 0.25% |

**Grade Mottled.**

| | |
|---|---|
| Combined Carbon, not under | 1.75% |
| Silicon, Maximum | 0.75% |
| „ Standard | 0.50% |
| „ Minimum | 0.25% |
| IMPURITIES. | |
| Phosphorus, not to exceed | 0.05% |
| Sulphur, not to exceed | 0.05% |
| Manganese, not to be under | 0.25% |

**Grade White.**

Carbon to be all in the Combined condition.

| | |
|---|---|
| Silicon, Maximum | 0.50% |
| „ Standard | 0.25% |
| „ Minimum | 0.10% |
| IMPURITIES. | |
| Phosphorus, not to exceed | 0.05% |
| Sulphur, not to exceed | 0.06% |
| Manganese, not to be under | 0.25% |

### Special Foundry Pig-Irons : Group I. Class C.

*Includes all Genuine "All-mine," Coke or Coal smelted Pig Irons, made with Semi-Cold Blast (temperature between 200 deg. F. and 600 deg F.) or Hot Blast (temperature between 600 deg. F. and 1,000 deg F.)*

**Grade Number I.**

| | |
|---|---|
| Combined Carbon, not to exceed | a Trace |
| Silicon, Maximum | 3.50% |
| „ Standard | 3.00% |
| „ Minimum | 2.75% |
| IMPURITIES. | |
| Phosphorus, not to exceed | 1.00% |
| Sulphur, not to exceed | 0.05% |
| Manganese, not to be under | 0.25% |

**Grade Number II.**

| | |
|---|---|
| Combined Carbon, not to exceed | 0.30% |
| Silicon, Maximum | 2.75% |
| „ Standard | 2.50% |
| „ Minimum | 2.00% |
| IMPURITIES. | |
| Phosphorus, not to exceed | 1.00% |
| Sulphur, not to exceed | 0.05% |
| Manganese, not to be under | 0.25% |

**Grade Number III.**

| | |
|---|---|
| Combined Carbon, not under | 0.30% |
| Silicon, Maximum | 2.00% |
| „ Standard | 1.75% |
| „ Minimum | 1.50% |
| IMPURITIES. | |
| Phosphorus, not to exceed | 1.00% |
| Sulphur, not to exceed | 0.05% |
| Manganese, not to be under | 0.25% |

**Grade Number IV.**

| | |
|---|---|
| Combined Carbon, not under | 0.50% |
| Silicon, Maximum | 1.50% |
| „ Standard | 1.25% |
| „ Minimum | 1.00% |
| IMPURITIES. | |
| Phosphorus, not to exceed | 1.00% |
| Sulphur, not to exceed | 0.06% |
| Manganese, not to be under | 0.25% |

**Grade Forge.**

| | |
|---|---|
| Combined Carbon, not under | 0.80% |
| Silicon, Maximum | 1.00% |
| „ Standard | 0.75% |
| „ Minimum | 0.50% |
| IMPURITIES. | |
| Phosphorus, not to exceed | 1.00% |
| Sulphur, not to exceed | 0.09% |
| Manganese, not to be under | 0.25% |

**Grade Mottled.**

| | |
|---|---|
| Combined Carbon, not under | 1.25% |
| Silicon, Maximum | 0.75% |
| „ Standard | 0.50% |
| „ Minimum | 0.25% |
| IMPURITIES. | |
| Phosphorus, not to exceed | 1.00% |
| Sulphur, not to exceed | 0.15% |
| Manganese, not to be under | 0.25% |

**Grade White.**

Carbon all to be in the Combined condition.

| | |
|---|---|
| Silicon Maximum | 0.50% |
| „ Minimum | 0.25% |
| „ Minimum | 0.10% |
| IMPURITIES. | |
| Phosphorus, not to exceed | 1.00% |
| Sulphur, not to exceed | 0.20% |
| Manganese, not to be under | 0.25% |

## English Foundry Pig-Irons: Group II. Class X. (Low Manganese).

**Grade Extra Number I.** (Silky or Silicious)

| | |
|---|---|
| Combined Carbon, not to exceed | a Trace |
| Silicon, Maximum | 5.0% |
| „ Standard | 4.0% |
| „ Minimum | 3.75% |

The average percentage of Silicon for two successive deliveries shall not be less than the standard percentage 4.0%.

The minimum Silicon will only be accepted provided the Combined Carbon is *within* the limit named

Impurities.

| | |
|---|---|
| Phosphorus, not to exceed | 1.75% |
| Sulphur, not to exceed | 0.05% |
| Manganese, not to exceed | 0.75% |

**Grade Number I.**

| | |
|---|---|
| Combined Carbon, not to exceed | 0.10% |
| „ „ Standard | 0.05% |
| Silicon, Maximum | 3.75% |
| „ Standard | 3.50% |
| „ Minimum | 3.25% |

The average percentage of Silicon for two successive deliveries shall not be less than the standard percentage 3.5%.

The minimum Silicon will only be accepted when the Combined Carbon is *within* the maximum limit of 0.10%.

Impurities.

| | |
|---|---|
| Phosphorus, not to exceed | 1.75% |
| Sulphur, not to exceed | 0.05% |
| Manganese, not to exceed | 0.75% |

**Grade Number II.**

| | |
|---|---|
| Combined Carbon, not to exceed | 0.20% |
| Silicon, Maximum | 3.50% |
| „ Standard | 3.25% |
| „ Minimum | 3.00% |

The average percentage of Silicon for two successive deliveries shall not be less than the standard percentage 3.25%.

The Minimum Silicon will only be accepted when the Combined Carbon is *within* the maximum limit of 0.20%.

Impurities.

| | |
|---|---|
| Phosphorus, not to exceed | 1.75% |
| Sulphur, not to exceed | 0.05% |
| Manganese, not to exceed | 0.75% |

**Grade Number III.**

| | |
|---|---|
| Combined Carbon, not to exceed | 0.30% |
| Silicon, Maximum | 3.25% |
| „ Standard | 3.00% |
| „ Minimum | 2.75% |

The average percentage of Silicon for two successive deliveries shall not be less than the standard percentage 3.00%.

The Minimum Silicon will only be accepted when the Combined Carbon is within the maximum limit 0.30%.

Impurities.

| | |
|---|---|
| Phosphorus, not to exceed | 1.75% |
| Sulphur, not to exceed | 0.05% |
| Manganese, not to exceed | 0.75% |

**Grade Number IV.**

| | |
|---|---|
| Combined Carbon, not to exceed | 0.40% |
| Silicon, Maximum | 3.00% |
| „ Standard | 2.75% |
| „ Minimum | 2.25% |

Impurities.

| | |
|---|---|
| Phosphorus, not to exceed | 1.75% |
| Sulphur, not to exceed | 0.06% |
| Manganese, not to exceed | 0.75% |

**Grade Number V.**

| | |
|---|---|
| Combined Carbon, not to exceed | 1.0% |
| Silicon, Maximum | 2.25% |
| „ Standard | 2.00% |
| „ Minimum | 1.75% |

Impurities.

| | |
|---|---|
| Phosphorus, not to exceed | 1.75% |
| Sulphur, not to exceed | 0.1% |
| Manganese, not to exceed | 0.75% |

**Grade Number "Forge."**

| | |
|---|---|
| Combined Carbon, not under | 0.4% |
| „ not to exceed | 1.5% |
| Silicon, Maximum | 1.75% |
| „ Standard | 1.25% |
| „ Minimum | 1.00% |

Impurities.

| | |
|---|---|
| Phosphorus, not to exceed | 1.75% |
| Sulphur, not to exceed | 0.15% |
| Manganese, not to exceed | 0.75% |

**Grade Number "Mottled to White."**

| | |
|---|---|
| Combined Carbon, not under | 1.0% |
| Silicon, Standard | 0.75% |
| „ Maximum | 1.0% |
| „ Minimum | 0.5% |

Impurities.

| | |
|---|---|
| Phosphorus, not to exceed | 1.75% |
| Sulphur, not to exceed | 0.25% |
| Manganese, not to exceed | 0.75% |

## English Foundry Pig-Irons: Group II. Class Y (High Manganese).

**Grade Extra Number I.** (Silky or Silicious).

| | |
|---|---|
| Combined Carbon, not to exceed | a Trace |
| Silicon, Maximum | 5.0% |
| „ Standard | 4.0% |
| „ Minimum | 3.75% |

The average percentage of Silicon for two successive deliveries shall not be less than the standard percentage 4.0%.

The minimum Silicon will only be accepted provided the Combined Carbon is *within* the limit named.

Impurities.

| | |
|---|---|
| Phosphorus, not to exceed | 1.75% |
| Sulphur, not to exceed | 0.05% |
| Manganese, *not* to be under | 0.90% |

**Grade Number I.**

| | |
|---|---|
| Combined Carbon, not to exceed | 0.10% |
| „ „ Standard | 0.05% |
| Silicon, Maximum | 3.75% |
| „ Standard | 3.50% |
| „ Minimum | 3.25% |

The average percentage of the Silicon for two successive deliveries shall not be less than the standard percentage 3.5%.

The minimum Silicon will only be accepted when the Combined Carbon is *within* the maximum limit of 0.10%.

Impurities.

| | |
|---|---|
| Phosphorus, not to exceed | 1.75% |
| Sulphur, not to exceed | 0.05% |
| Manganese, *not* to be under | 0.90% |

**Grade Number II.**

| | |
|---|---|
| Combined Carbon, not to exceed | 0.20% |
| Silicon, Maximum | 3.50% |
| „ Standard | 3.25% |
| „ Minimum | 3.00% |

The average percentage of Silicon for two successive deliveries shall not be less than the standard percentage 3.25%.

The Minimum Silicon will only be accepted when the Combined Carbon is *within* the maximum limit of 0.20%.

Impurities.

| | |
|---|---|
| Phosphorus, not to exceed | 1.75% |
| Sulphur, not to exceed | 0.05% |
| Manganese, *not* to be under | 0.90% |

**Grade Number III.**

| | |
|---|---|
| Combined Carbon not to exceed | 0.30% |
| Silicon, Maximum | 3.25% |
| „ Standard | 3.00% |
| „ Minimum | 2.75% |

The average percentage of Silicon for two successive deliveries shall not be less than the standard percentage 3.00%.

The Minimum Silicon will only be accepted when the Combined Carbon is within the maximum limit 0.30%.

Impurities.

| | |
|---|---|
| Phosphorus, not to exceed | 1.75% |
| Sulphur, not to exceed | 0.05% |
| Manganese, *not* to be under | 0.90% |

**Grade Number IV.**

| | |
|---|---|
| Combined Carbon, not to exceed | 0.4% |
| Silicon, Maximum | 3.0% |
| „ Standard | 2.75% |
| „ Minimum | 2.25% |

Impurities

| | |
|---|---|
| Phosphorus, not to exceed | 1.75% |
| Sulphur, not to exceed | 0.06% |
| Manganese, *not* to be under | 0.90% |

**Grade Number V.**

| | |
|---|---|
| Combined Carbon, not to exceed | 1.50% |
| Silicon, Maximum | 2.25% |
| „ Standard | 2.00% |
| „ Minimum | 1.75% |

Impurities

| | |
|---|---|
| Phosphorus, not to exceed | 1.75% |
| Sulphur, not to exceed | 0.10% |
| Manganese, *not* to be under | 0.90% |

**Grade Number "Forge."**

| | |
|---|---|
| Combined Carbon, not under | 0.4% |
| „ „ not to exceed | 1.5% |
| Silicon, Maximum | 1.75% |
| „ Standard | 1.25% |
| „ Minimum | 1.00% |

Impurities.

| | |
|---|---|
| Phosphorus, not to exceed | 0.9% |
| Sulphur, not to exceed | 0.1% |
| Manganese, *not* to be under | 0.75% |

**Grade Number "Mottled to White."**

| | |
|---|---|
| Combined Carbon, not under | 1.0% |
| Silicon, Maximum | 1.0% |
| „ Standard | 0.75% |
| „ Minimum | 0.50% |

Impurities.

| | |
|---|---|
| Phosphorus, not to exceed | 1.75% |
| Sulphur, not to exceed | 0.25% |
| Manganese, *not* to be under | 0.9% |

## Scotch Foundry Pig-Irons: Group III. (High Manganese),

**Grade, Extra Number I.** (Silky or Silicious).

| | |
|---|---|
| Combined Carbon, not to exceed | a Trace |
| Silicon, Maximum | 5.0% |
| „ Standard | 4.0% |
| „ Minimum, | 3.75% |

The average percentage of Silicon for two successive deliveries shall not be less than the Standard percentage 4.0%

The Minimum Silicon will only be accepted provided the Combined Carbon is *within* the limit named

Impurities

| | |
|---|---|
| Phosphorus, not to exceed | 0.9% |
| Sulphur, not to exceed | 0.05% |
| Manganese, *not* to be under | 0.75% |

**Grade Number I.**

| | |
|---|---|
| Combined Carbon, not to exceed | 0.15% |
| „ Standard | 0.05% |
| Silicon, Maximum. | 3.75% |
| „ Standard | 3.50% |
| „ Minimum | 3.25% |

The average percentage of the Silicon for two successive deliveries shall not be less than the Standard percentage 3.5%.

The Minimum Silicon will only be accepted when the Combined Carbon is *within* the Maximum limit 0.15%

Impurities

| | |
|---|---|
| Phosphorus, not to exceed | 0.9% |
| Sulphur, not to exceed | 0.05% |
| Manganese *not* to be under | 0.75% |

## Group III. (High Manganese) (Contd.).

### Grade Number II.

| | |
|---|---|
| Silicon, Maximum | 3.50% |
| „ Standard | 3.25% |
| „ Minimum | 3.00% |

The average percentage of Silicon for two successive deliveries shall not be less than the standard percentage of 3.25%.

IMPURITIES.

| | |
|---|---|
| Phosphorus, not to exceed | 0.9% |
| Sulphur, not to exceed | 0.05% |
| Manganese, *not* to be under | 0.75% |

### Grade Number III.

| | |
|---|---|
| Silicon, Maximum | 3.25% |
| „ Standard | 3.00% |
| „ Minimum | 2.75% |

The average percentage of Silicon for two successive deliveries shall not be less than the standard percentage 3.0%.

IMPURITIES.

| | |
|---|---|
| Phosphorus, not to exceed | 0.9% |
| Sulphur, not to exceed | 0.05% |
| Manganese, *not* to be under | 0.75% |

### Grade Number IV.

| | |
|---|---|
| Silicon, Maximum | 3.00% |
| „ Standard | 2.75% |
| „ Minimum | 2.25% |

IMPURITIES.

| | |
|---|---|
| Phosphorus, not to exceed | 0.9% |
| Sulphur, not to exceed | 0.05% |
| Manganese, *not* to be under | 0.75% |

### Grade Number V.

| | |
|---|---|
| Silicon, Maximum | 2.25% |
| „ Standard | 2.00% |
| „ Minimum | 1.75% |

IMPURITIES.

| | |
|---|---|
| Phosphorus, not to exceed | 0.9% |
| Sulphur, not to exceed | 0.1% |
| Manganese, *not* to be under | 0.75% |

### Grade Number "Forge."

| | |
|---|---|
| Combined Carbon, not under | 0.4% |
| „ „ not to exceed | 1.5% |
| Silicon, Maximum | 1.75% |
| „ Standard | 1.25% |
| „ Minimum | 1.00% |

IMPURITIES.

| | |
|---|---|
| Phosphorus, not to exceed | 1.75% |
| Sulphur, not to exceed | 0.15% |
| Manganese, *not* to be under | 0.9% |

### Grade Number "Mottled to White."

| | |
|---|---|
| Combined Carbon, not under | 1.0% |
| Silicon, Maximum | 1.0% |
| „ Standard | 0.75% |
| „ Minimum | 0.50% |

IMPURITIES.

| | |
|---|---|
| Phosphorus, not to exceed | 0.9% |
| Sulphur, not to exceed | 0.25% |
| Manganese, *not* to be under | 0.75% |

## "East-Coast" Hematite Pig-Irons: Group IV. (High Manganese.)

### Grade Extra Number I. (Silky or Silicious).

| | |
|---|---|
| Combined Carbon, not to exceed | a Trace |
| Silicon, Maximum | 5.0% |
| „ Standard | 4.0% |
| „ Minimum, | 3.75% |

The average percentage of Silicon for two successive deliveries shall not be less than the Standard percentage 4.0%.

The Minimum Silicon will only be accepted provided the Combined Carbon is *within* the limit named.

IMPURITIES.

| | |
|---|---|
| Phosphorus, not to exceed | 0.05% |
| Sulphur, not to exceed | 0.05% |
| Manganese *not* to be under | 0.70% |

### Grade Number I.

| | |
|---|---|
| Combined Carbon, not to exceed | 0.15% |
| Silicon, Maximum | 3.75% |
| „ Standard | 3.50% |
| „ Minimum | 3.25% |

The average percentage of Silicon for two successive deliveries shall not be less than the Standard percentage 3.50%.

IMPURITIES.

| | |
|---|---|
| Phosphorus, not to exceed | 0.05% |
| Sulphur, not to exceed | 0.05% |
| Manganese *not* to be under | 0.70% |

### Grade Number II.

| | |
|---|---|
| Combined Carbon, not to exceed | 0.25% |
| Silicon, Maximum | 3.25% |
| „ Standard | 3.00% |
| „ Minimum | 2.75% |

The average percentage of Silicon for two successive deliveries shall not be less than the standard percentage of 3.00%.

IMPURITIES.

| | |
|---|---|
| Phosphorus, not to exceed | 0.05% |
| Sulphur, not to exceed | 0.05% |
| Manganese, *not* to be under | 0.70% |

### Grade Number III.

| | |
|---|---|
| Combined Carbon, not to exceed | 0.35% |
| Silicon, Maximum | 3.00% |
| „ Standard | 2.75% |
| „ Minimum | 2.25% |

IMPURITIES.

| | |
|---|---|
| Phosphorus, not to exceed | 0.05% |
| Sulphur, not to exceed | 0.05% |
| Manganese, *not* to be under | 0.70% |

### Grade Number IV.

| | |
|---|---|
| Silicon, Maximum | 2.75% |
| „ Standard | 2.25% |
| „ Minimum | 2.00% |

The average percentage of Silicon for two successive deliveries shall approximate closely to the standard percentage 2.25%.

IMPURITIES.

| | |
|---|---|
| Phosphorus, not to exceed | 0.06% |
| Sulphur, not to exceed | 0.06% |
| Manganese, *not* to be under | 0.70% |

### Grade Number V.

| | |
|---|---|
| Combined Carbon, not to exceed | 1.5% |
| Silicon, Maximum | 2.25% |
| „ Standard | 2.00% |
| „ Minimum | 1.75% |

IMPURITIES.

| | |
|---|---|
| Phosphorus, not to exceed | 0.06% |
| Sulphur, not to exceed | 0.05% |
| Manganese, *not* to be under | 0.70% |

### Grade Number "Forge."

| | |
|---|---|
| Combined Carbon, not under | 0.4% |
| „ „ not to exceed | 1.5% |
| Silicon, Maximum | 1.75% |
| „ Standard | 1.25% |
| „ Minimum | 1.00% |

IMPURITIES.

| | |
|---|---|
| Phosphorus, not to exceed | 0.06% |
| Sulphur, not to exceed | 0.05% |
| Manganese, *not* to be under | 0.70% |

### Grade Number "Mottled to White."

| | |
|---|---|
| Combined Carbon, not under | 1.5% |
| Silicon, Maximum | 1.0% |
| „ Standard | 0.75% |
| „ Minimum | 0.50% |

IMPURITIES.

| | |
|---|---|
| Phosphorus, not to exceed | 0.06% |
| Sulphur, not to exceed | 0.25% |
| Manganese, *not* to be under | 0.70% |

## "West-Coast" Hematite Pig-Irons: Group IV. (Low Manganese).

### Grade, Extra Number I. (Silky or Silicious)

| | |
|---|---|
| Combined Carbon, not to exceed | a Trace |
| Silicon, Maximum | 5.0% |
| „ Standard | 4.0% |
| „ Minimum, | 3.75% |

The average percentage of Silicon for two successive deliveries shall not be less than the Standard percentage 4.0%.

The Minimum Silicon will only be accepted provided the Combined Carbon is *within* the limit named.

IMPURITIES.

| | |
|---|---|
| Phosphorus, not to exceed | 0.05% |
| Sulphur, not to exceed | 0.05% |
| Manganese, not to exceed | 0.50% |

### Grade Number I.

| | |
|---|---|
| Combined Carbon, not to exceed | 0.15% |
| Silicon, Maximum | 3.75% |
| „ Standard | 3.50% |
| „ Minimum | 3.25% |

The average percentage of Silicon for two successive deliveries shall not be less than the Standard percentage 3.50%.

IMPURITIES.

| | |
|---|---|
| Phosphorus, not to exceed | 0.05% |
| Sulphur, not to exceed | 0.05% |
| Manganese, not to exceed | 0.50% |

### Grade Number II.

| | |
|---|---|
| Combined Carbon, not to exceed | 0.25% |
| Silicon, Maximum | 3.25% |
| „ Standard | 3.00% |
| „ Minimum | 2.75% |

The average percentage of Silicon for two successive deliveries shall not be less than the Standard percentage of 3.00%.

IMPURITIES.

| | |
|---|---|
| Phosphorus, not to exceed | 0.05% |
| Sulphur, not to exceed | 0.05% |
| Manganese, not to exceed | 0.50% |

### Grade Number III.

| | |
|---|---|
| Combined Carbon, not to exceed | 0.35% |
| Silicon, Maximum | 3.00% |
| „ Standard | 2.75% |
| „ Minimum | 2.25% |

IMPURITIES.

| | |
|---|---|
| Phosphorus, not to exceed | 0.05% |
| Sulphur, not to exceed | 0.05% |
| Manganese, not to exceed | 0.50% |

### Grade Number IV.

| | |
|---|---|
| Silicon, Maximum | 2.75% |
| „ Standard | 2.25% |
| „ Minimum | 2.00% |

The average percentage of Silicon for two successive deliveries shall approximate closely to the Standard percentage 2.25%.

IMPURITIES.

| | |
|---|---|
| Phosphorus, not to exceed | 0.06% |
| Sulphur, not to exceed | 0.06% |
| Manganese, not to exceed | 0.50% |

### Grade Number V.

| | |
|---|---|
| Combined Carbon, not to exceed | 1.5% |
| Silicon, Maximum | 2.25% |
| „ Standard | 2.00% |
| „ Minimum | 1.75% |

IMPURITIES.

| | |
|---|---|
| Phosphorus, not to exceed | 0.06% |
| Sulphur, not to exceed | 0.06% |
| Manganese, not to exceed | 0.5% |

### Grade Number "Forge."

| | |
|---|---|
| Combined Carbon, not under | 0.4% |
| „ „ not to exceed | 1.5% |
| Silicon, Maximum | 1.75% |
| „ Standard | 1.25% |
| „ Minimum | 1.00% |

IMPURITIES.

| | |
|---|---|
| Phosphorus, not to exceed | 0.06% |
| Sulphur, not to exceed | 0.06% |
| Manganese, not to exceed | 0.5% |

### Grade Number "Mottled to White."

| | |
|---|---|
| Combined Carbon, not under | 1.5% |
| Silicon, Maximum | 1.0% |
| „ Standard | 0.75% |
| „ Minimum | 0.50% |

IMPURITIES.

| | |
|---|---|
| Phosphorus, not to exceed | 0.06% |
| Sulphur, not to exceed | 0.25% |
| Manganese, not to exceed | 0.5% |

## Specifications for Foundry Pig-Irons : Samples of Pig-Irons.

(*For descriptions and analyses see Table VI., page* 153.)

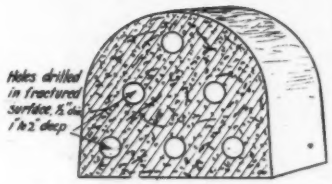


FIG. 1.— METHOD OF DRILLING FOR SAMPLES.

FIG. 2.—TEST NO. 3.

FIG. 3.—TEST NO. 15.

FIG. 4.—TEST NO. 6.

FIG. 5.—TEST NO. 5.

FIG. 6.—TEST NO. 8.

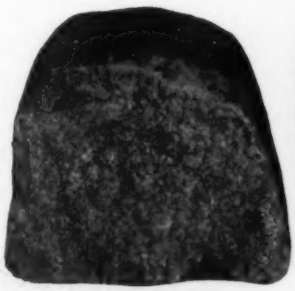

FIG. 7 —TEST NO. 10.

FIG. 8.—TEST NO. 4.

FIG. 9.—TEST NO. 7.

**Specifications for Foundry Pig-Irons: Samples of Pig-Irons**—*(Continued.)*

*(For descriptions and analyses see Table VI., page 153.)*

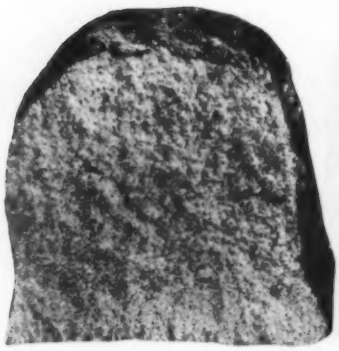

FIG. 10.—TEST NO. 11.

FIG. 11.—TEST NO. 1.

FIG. 12.—TEST NO. 9.

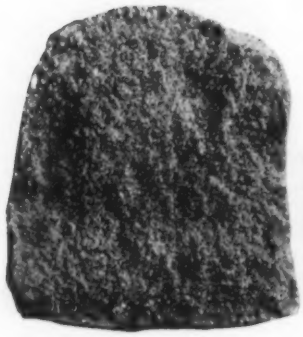

FIG. 13.—TEST NO. A/16.

FIG. 14.—TEST NO. B/17.

FIG. 15.—TEST NO. 2.

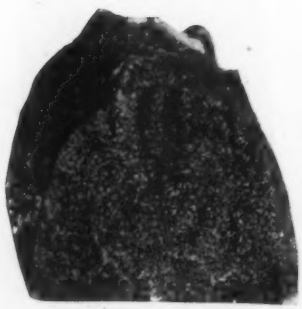

FIG. 16.—TEST NO. 14.

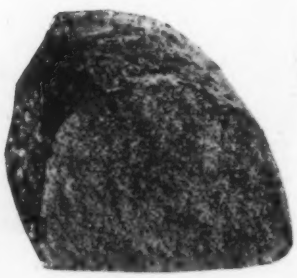

FIG. 17.—TEST NO. 13.

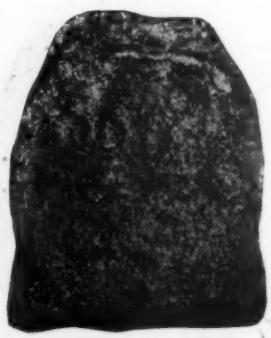

FIG. 18.—TEST NO. 12.

TABLE VI.

| Fig. | Test No. | Grade number. | Description of sample. Specification. | Brand. | Ordinary Analysis %. T.C. | G.C. | C.C. | Si. | P. | S. | Mn. | Partial Rational Analysis % by Wt. S. combined with carbon. | S. combined with Mn. | MnS | P. in solid solution. | P. in free $Fe_3P$. | $Fe_3P$. | $Fe_3C$. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 3 | IV. | Group I., Class A | Warner | 3.44 | 2.97 | 0.47 | 0.56 | 0.11 | 0.037 | 0.32 | 0.001 | 0.036 | 0.098 | 0.08 | 0.03 | 0.19 | 7.05 |
| 3 | 15 | (Grey) III. | Group I., Class B | Swedish | 3.23 | 2.61 | 0.62 | 0.90 | 0.06 | 0.037 | trace | 0.004 | 0.033 as FeS | nil | 0.04 | 0.02 | 0.13 | 9.30 |
| 4 | 6 | IV. | Group I., Class A | 1XL Bradley CB | 2.96 | 2.57 | 0.39 | 0.46 | 0.38 | 0.162 | 0.48 | 0.005 | 0.157 | 0.427 | 0.17 | 0.21 | 1.35 | 5.85 |
| 5 | 5 | Forge | Group I., Class C | G. & R. T. Special | 3.36 | 2.88 | 0.48 | 0.72 | 0.81 | 0.075 | 0.96 | 0.006 | 0.069 | 0.187 | 0.34 | 0.47 | 3.02 | 7.20 |
| 6 | 8 | Extra No. 1 | Group II., Class X | Wellingborough | 3.60 | 2.90 | trace | 5.99 | 1.56 | 0.024 | 0.30 | 0.017 | 0.007 | 0.019 | 0.53 | 1.00 | 6.42 | nil |
| 7 | 10 | ,, ,, | ,, ,, | Lloyds | 3.05 | 3.05 | trace | 5.76 | 1.54 | 0.017 | 0.25 | 0.009 | 0.008 | 0.022 | 0.49 | 1.05 | 6.74 | nil |
| 8 | 4 | Forge | Group II., Class Y | G. & R. T. Hatherton | 3.50 | 2.78 | 0.55 | 1.18 | 1.13 | 0.084 | 1.34 | 0.005 | 0.079 | 0.215 | 0.28 | 0.85 | 3.46 | 8.75 |
| 9 | 7 | ,, | ,, ,, | Trent | 3.33 | 2.75 | 0.65 | 0.72 | 1.81 | 0.047 | 1.28 | 0.002 | 0.045 | 0.122 | 0.45 | 1.36 | 8.73 | 4.65 |
| 10 | 11 | Mottled to white | ,, ,, | Sheepbridge | 3.00 | 2.75 | 0.31 | 1.64 | 0.64 | 0.039 | 0.77 | 0.001 | 0.038 | 0.103 | 0.23 | 0.41 | 2.63 | 4.65 |
| 11 | 1 | Forge | Group III. | Glengarnock | 3.08 | 2.77 | 0.19 | 3.00 | 0.57 | 0.101 | 0.88 | 0.005 | 0.096 | 0.261 | 0.21 | 0.36 | 2.31 | 2.85 |
| 12 | 9 | III. | Group III. | | 3.27 | 3.08 | trace | 5.06 | trace | 0.021 | 0.41 | 0.004 | 0.017 | 0.046 | trace | nil | nil | nil |
| 13 | A 16 | Extra No. 1 | Group IV., East Coast | Gyers Mills & Co. | 2.98 | 2.98 | trace | 5.12 | trace | 0.020 | 0.40 | 0.003 | 0.017 | 0.046 | trace | nil | nil | nil |
| 14 | B 17 | ,, ,, | ,, ,, | | 3.06 | 3.06 | trace | 4.38 | trace | 0.013 | 0.14 | 0.002 | 0.011 | 0.030 | trace | nil | nil | nil |
| 15 | 2 | ,, ,, | Group IV., West Coast | Ulverstone | 3.36 | 3.36 | 0.17 | 4.30 | trace | 0.012 | 0.15 | 0.001 | 0.011 | 0.030 | trace | nil | n l | 2.36 |
| 16 | 14 | ,, ,, | ,, ,, | ,, | 3.22 | 3.05 | 0.15 | 4.35 | trace | 0.012 | 0.14 | 0.001 | 0.011 | 0.030 | trace | nil | n l | 2.35 |
| 17 | 13 | ,, ,, | ,, ,, | ,, | 3.51 | 3.36 | 0.15 | 4.10 | trace | 0.012 | 0.15 | 0.001 | 0.011 | 0.030 | trace | nil | n l | 2.49 |
| 17 | 13 A | ,, ,, | ,, ,, | ,, | 3.40 | 3.24 | 0.16 | 4.10 | trace | 0.012 | 0.15 | 0.001 | 0.011 | 0.030 | trace | nil | nil | 10.20 |
| 18 | 12 | Mottled to white | ,, ,, | Central portion of 13 Clyde | 3.40 | 2.72 | 0.68 | 0.60 | trace | 0.132 | 0.33 | 0.011 | 0.121 | 0.329 | trace | nil | nil | |

## Discussion.

PROFESSOR TURNER remarked that Mr. Parker had had the control of a laboratory where there was an opportunity of doing careful, scientific work, and he had given them the result of that work. The Paper might be described as a very suitable reply to the suggestions voiced during the past two or three years to the effect that grading by analysis was all a mistake, and, more particularly, that grading by silicon was quite wrong. That suggestion had been received in some quarters quite enthusiastically. He himself did not think anyone seriously intended that they should grade by silicon alone, though the Papers to which he was referring had rather taken that line as if someone had suggested it. It was known that, broadly speaking, if silicon were added to cast iron which was deficient in silicon, that iron would be made more grey and its grain would be opened; but other things would have to be considered besides silicon, and iron was generally graded on the silicon and combined carbon, as Mr. Parker had reminded them. As a general rule, if the iron were cast in a small size it would have a close grain, whereas the same iron in a larger section would have an open grain. That was the general rule, but it was, of course, subject to difference in composition, and that a small-grain iron cast in a larger size might have a particularly open grain. With more silicon, a greyish iron would be got, and with less silicon a white iron. But there must also be taken into consideration the other circumstances and the other elements of the composition. The Papers to which he had referred had been particularly those written by Mr. Adamson. These Papers had been received as if they shed a new light on the subject of grading. Mr. Adamson thought he had discovered that the size of the graphite was the important matter in connection with the grading and the strength of irons. They would perhaps remember that eight or nine years ago they were shown the different sizes of graphite, and how those corresponded with the grading of iron. In fact, it was no new discovery at all. He believed that Mr. Parker's system of grading upon silicon and combined carbon, and then classifying according to the phosphorus and manganese, was based upon strictly scientific principles and was the kind of system that was going ultimately to remain. The numbers which Mr. Parker had supplied to them might appear at first sight rather complicated. They certainly required careful reading. He would suggest that a brief summary preceding the lists would be very helpful. The lists would make things much clearer, and anyone who was familiar with the composition of irons from different localities and with the different grades would be able at once to find the way through that somewhat lengthy document, and it would then be practically simple. There were sundry minor matters that Mr. Parker had referred to, and one on which he (Professor Turner) might say a word or two. The first point was whether they, as foundrymen, were entitled to ask the blast-furnace manager to specify the ore or the composition of the ore; for instance, that it should not contain more than a certain amount of sulphur, or should be of a particular kind. He thought, broadly speaking, the foundryman ought to be content to get an iron of a certain composition, and a certain character, and should leave the blast furnaceman to make that iron in any way that he might prefer. (Hear, hear.) There was, of course, the limitation that if the iron was sold as "all-mine" iron, for example, it should be all-mine, or if sold as "hematite" should be hematite and not brown hematite, as sometimes happened. He had heard of iron made from phosphoric brown hematite, being called hematite iron. He

supposed from one point of view it was hematite iron, but if it was phosphoric it certainly did not answer to what was generally understood when hematite iron was specified. It was a very good plan to state what ores were used, but when very different ores were mixed, the approximate proportions of the best should be specified. With regard to the classification of Cleveland irons, Mr. Parker was introducing a new number for grading as distinct from the number that was now commonly employed. He (Professor Turner) thought that where they had a trade that had been carried on for half a century producing pig-iron in larger quantities than in any other iron district in the country, it would cause a little difficulty if one introduced a new number. Makers and buyers would be slow to take it up and in the meantime there would be confusion. If they could continue the same numbers with some explanatory phrase he thought it would be better. On the whole, he should like to say that Mr. Parker's Paper on the question of grading was the most comprehensive and the most scientific he had met.

Mr. Hailstone said that in any district in this country pig-iron could be bought, say, of twelve different brands, all with analyses which would enable them to produce any type of castings. He was not running down the specifications which Mr. Parker had given, but he did not think that in ordinary foundry practice there was any need for so many grades, or he might say different sections of grades. With reference to the grading of ordinary pig-iron by combined carbon and silicon, he considered that ordinary foundry irons should be bought by chemical analysis and that the grading of the fracture would mean nothing. For instance, in making light castings successfully, it was well known that without the trouble of examining the fracture they could mix irons containing 5 per cent. of silicon with those containing 1 per cent. of silicon and others containing 2½ per cent. of silicon and produce perfect castings containing 2.7 per cent. of silicon. With regard to the coke question, it surprised him that Mr. Parker should have put on the screen a bad analysis of furnace coke. He (Mr. Hailstone) always thought that the blast-furnace people bought their coke on chemical analysis. He knew that if certain furnaces in the Staffordshire district received coke like that described, they would refuse it. As to the method of sampling, Mr. Parker, he (Mr. Hailstone), and also Mr. Cook, had had the method mentioned under discussion several times. He, however, still held that his own method was at least one of the best. It had proved itself the best on a number of occasions when he had had disputes with the blast-furnace people. Mr. Parker showed them a fracture of Scotch iron with what were known as hob-nails on the top of the pig. He would be glad to know the reasons for these holes appearing in that pig.

Mr. F. J. Cook quite agreed with Mr. Hailstone that for ordinary foundry work it was possible to get all that was wanted from a dozen brands of iron. But he did not think that covered the whole of the ground. Mr. Parker had dealt with most of the irons made in the British Isles and had classified them according to the grades to which they belonged, and they all owed to him a debt of gratitude for having done so. From a general observation of the classification of brands as presented, he quite agreed that Mr. Parker had classified them very closely, and he (Mr. Cook) would be quite willing to accept that classificaton for all ordinary irons, but would be inclined to differ as to the classification of irons of a special character requiring very great strength. Nowhere in the specifications had Mr. Parker said anything in regard to total carbon. From practical experience he (Mr. Cook) was quite sure that total carbon had a very great influence on the physical properties and the strength of castings. For the class of casting to which he was referring he would much prefer to take the total carbon rather than the combined carbon, as the latter largely depended on the rate of cooling and the other elements that were present. Mr. Parker had dealt with the other elements (the ruling elements), very closely, but some of the brands of iron shown on the board were of a special class, and while they would fulfil his specification, yet the total carbon in some of them would have a variation of from 0.4 to 0.6 per cent., which would be quite sufficient to cause a great difference in the physical properties of the metal. With ordinary No. 3 and other pig-irons of that class, total carbon was not of so much importance; but with irons that were subject to great heat and must not grow, and also where high strengths were required, total carbon was one of the great ruling factors. If Mr. Parker would therefore supplement his specifications with regard to these special classes, he (Mr. Cook) would be quite willing to accept his list.

Professor Turner: Are you for high total carbon or for low total carbon?

Mr. Cook replied that he was for low total carbons for great strength, and for not growing under high temperatures. A large amount of total carbon meant a large amount of graphite, which was shown by Dr. Carpenter to aid the growth of cast iron when subjected to repeated heating. With regard to the ores used, he thought that they, as foundrymen, must leave that absolutely to the blast-furnace manager, although he concurred with the lecturer that where a firm agreed to supply something of a special character, or mentioned the ores used, it was quite reasonable to demand exactly what was specified. To himself, however, it would have no special attraction. He would not judge by the ores used, but rather by the physical properties and the way the iron worked in the foundry. He, however, thought it was quite right to insist upon a firm keeping to its specifications with regard to the temperature of the blast. They ought to know the temperature of the blast, because some of those irons in Group II. were made at vastly different temperatures. Some were made in very large blast furnaces with high temperatures, and others in small furnaces with lower temperatures, and although all would come within the specifications given, they would differ very widely in their physical properties. Therefore the question of the blast was very important. With regard to drilling the holes in the end of the pig for analysis, that was an old question come up again. A great many of these differences of opinion often depended upon what one was used to, but he had no hesitation in saying that he could produce a large number of pigs in which the analysis, particularly in regard to the sulphur, would be more reliable, more true to the pig, if the hole was drilled straight through from top to bottom, than if the drilling was done by Mr. Parker's method. The former also was to be commended as only one hole required to be drilled. If Dr. Stead's method of taking sulphur prints were recalled, it would be seen that the sulphur would be found in different parts of the pig, according to the temperature at which it was run. With pigs of that description the hole drilled straight through would be better as giving a truer result.

Mr. C. Heggie said that with regard to the increase of phosphorus from 1.56 to 1.75 per cent., that was all very well if they were working with brands of iron which could reduce, but he thought they were certainly working to a dangerous limit if they got the phosphorus up to 1.75 per cent.

The CHAIRMAN said that if foundrymen were going to ask the blast furnaceman to let them see the charges put in and were allowed to do so they would probably be just as much instructed as would be an inspector who saw the foundryman putting the pig-iron into the cupolas. Any foundryman would know how useful that would be. He was afraid that the blast furnaceman would be content to go on in his usual way, and would continue to tell his customers as little as he told them now. He had not had time to master the system of purchase by analysis recommended by Mr. Parker, but with regard to standardising grades from analysis, he recalled the fact that the Conference which met a year or two ago in reference to this matter (Mr. Pilkington representing the British Foundrymen's Association, and Mr. W. J. Foster, of Darlaston, the Staffordshire Iron and Steel Institute), came to the conclusion that time was not ripe for the standardisation of pig-iron by analysis. One of the difficulties in the way of standardisation, of course, was the undoubted conservatism of blast-furnacemen. On the other hand, there were a very considerable number of foundrymen to whom the figures in Mr. Parker's Paper would be so much Greek. That, of course, was a matter which was being mended; but until those people were brought up to the mark by technical education, he thought that grading by fracture was likely to continue to largely obtain. By that time he had no doubt the blast-furnacemen themselves would be in the position and under the necessity of working to analysis more thoroughly than they were at the present time. Returning to the subject of mixtures of ores, he recalled that Professor Sexton, some six or seven years ago, said that there were then no Scotch pig-irons, or practically none, being made with the ores of 25 years ago. That was one of the things they had to contend with. Certain fields of ore were getting worked out, and others were coming into use. That rather placed foundrymen in a difficulty with regard to specifying the ores blast-furnacemen were to use.

MR. PARKER, in reply, said that it had been his aim to get this matter into a shape in which it would attract the attention of both users and makers, and of all the people interested in any way in cast iron; because he thought, with the example of America and Germany and other nations before them, it was high time that the English people showed that they could co-operate on a matter of this description and get out satisfactory standards. With regard to Professor Turner's comments, he knew Mr. Adamson very well, and the latest thing that he got from him was that he based most of his valuable characteristics of pig-iron on the allotropical forms of graphite. It was rather getting into the higher realms of chemical practice to discuss allotropic forms—forms other than the ordinary temper graphite and plate or crystal graphite. With regard to an "Introduction to the Specifications," he would be very glad to add that to the specifications, and he thought that probably it would be of advantage to do so. He agreed with all the speakers who had mentioned the question of ores. When they got the Paper and read it carefully through they would see that he made no attempt to specify the ores. That was entirely for the manufacturer of the pig-iron, and no one had the right to specify to the manufacturer what ores he should use. But if an iron were sold as a hematite iron, they had a perfect right to demand that hematite ore be used in its manufacture. With regard to the change of grade name of No. 4 forge to No. 5, one of his reasons was that it was only in the Cleveland district that that number was in use. He believed that in the Staffordshire district there were No. 5's used, and he thought that that classification required to be extended throughout the country. He hoped that manufacturers would come in generally and agree upon some common method of grading, because it was not to the advantage of any industry for every man to be a law unto himself in such matters. With regard to Mr. Hailstone's remark, of course, the Paper did not recommend that every foundryman should carry the whole stock of pig-iron of every grade given in the lists. But supposing he wanted a particular grade for his work, he had in those specifications the limits by which he could requisition exactly what he wanted. When the manufacturers found that they were getting a series of these specifications from buyers, they would then be bound to standardise all these irons, as was actually being done with the firm with which he was connected. With regard to the brands and grading numbers, it should be noted that the class and number or grade of iron ordered influenced the price. If they ordered a Grade II., Class *X* they would not expect to pay the same as they would for Grade III. or Grade I. of the same class. With regard to the holes in the Scotch pig-iron, he had not investigated that special point. The holes might be due to the action of water on the pig-iron. There might be water turned on to the pig-iron while still molten, and seeing that silicon was low and the sulphur and manganese not high the holes may have been due to this. With regard to the total carbon, they would notice that in the table he showed the maximum total carbon was 3.5 per cent. and the minimum 2.9 per cent., a variation of 0.6 per cent. He thought that would not affect the tensile strength of the mixture. With regard to the quality of some brands, it should be understood that some furnaces made two distinct qualities under the same brand name, which he thought was rather a bad practice. There was, for instance, a brand which was sold in two grades, one hot blast, and the other cold blast. Therefore, foundrymen in compiling their specifications must be careful as to which grade they were going to purchase. With regard to the phosphorus limit, he thought that Mr. Heggie would find that except in very strong irons, 1.75 per cent. of phosphorus was not a very serious matter, though it might be serious in a good deal of ordinary iron castings. With regard to the Conference on grading by analysis, he thought a better decision could have been come to. He did not think a sufficient number of users were called in; there were more makers than users in the Conference, and more sellers than users, so that it was rather a lob-sided Conference. Mr. Buchanan said that the ordinary foundryman would not need to order to those specifications, but as a matter of fact all foundrymen now ordered their iron to a certain grade number. Whether the limits were specified on the order or not, they were *naturally implied by the number, i.e., grade ordered.* If the foundryman ordered No. 1, he implied a high-silicon iron, and it would not be right after the silicon limits had been in this way specified to send him an iron with only about 0.5 per cent. of silicon.

## L.C.C. School of Engineering and Navigation.

On February 22, at the L.C.C. School of Engineering and Navigation, Poplar, E., a conversazione was held under the joint direction of the Associations of Electrical and Mechanical Engineering Students of that Institution. The programme included inspections of the different departments, exhibitions and demonstrations, lecturettes and concerts, the whole making an excellent entertainment, participated in by several hundred students and visitors. Regarding the Institution and its work, we propose publishing in a near issue particulars of the same, with illustrations of the departments.

# Moulding Socket and Flange Taper Pipes and Double-Socket Pipes in Loam.

By Sidney G. Smith.

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### Socket and Flange Taper Pipes.

The following are the details of the procedure of moulding in loam a flange and socket taper pipe. The flange is cast down to ensure soundness and clean-

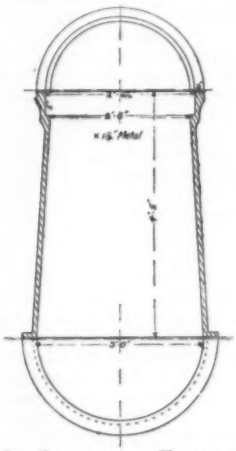

FIG. 1. SOCKET AND FLANGE TAPER PIPE.

ness whilst the socket can more easily be made sound and clean by means of a feeding head, which in this case is 10 in. long, tapering to 3½ in. at the top. This would, with suitable iron, feed the casting perfectly well, even without the aid of feeding rods.

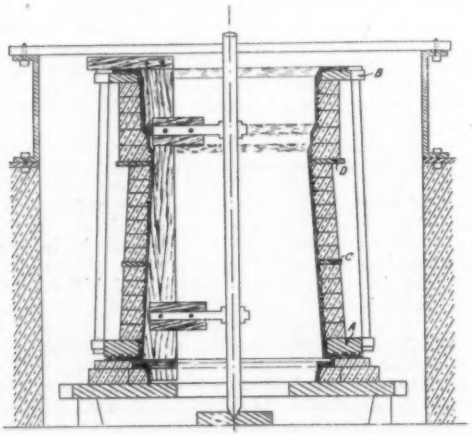

FIG. 3.—MOULD-BOARD SET AND SECTION OF WALL BUILT.

Since the largest end is cast down, it is necessary that the mould should pass over the body core when set in place, and to do this the mould must be lifted bodily. This is done by the top and bottom rings A and B, Figs. 2 and 3, being bolted together, the entire mould from the flange being slung by eye-bolts from the top ring B, Figs. 2 and 6. The core is a bricked one. The description of the core spindle

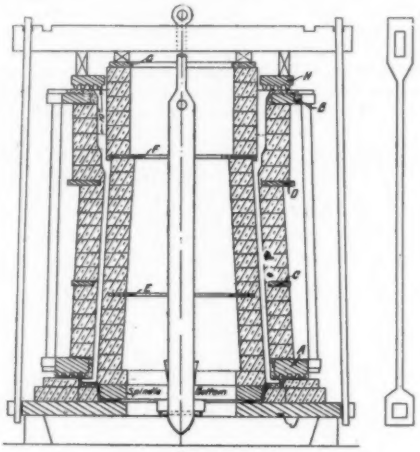

FIG. 2.—SECTION OF MOULD CORE AND TACKLE.

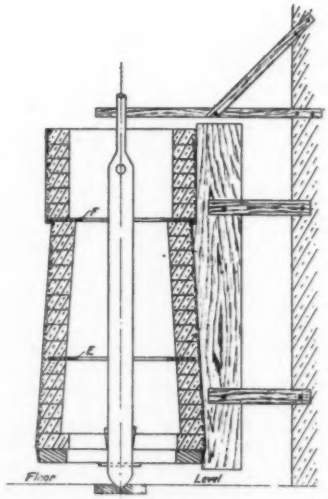

FIG. 4.—CORE-BOARD SET AND SECTION OF CORE BUILT.

and spindle bottom is omitted, as these particulars have been given in previous articles.

Fig. 1 is a sketch of the pipe; Fig. 2 is a section of the mould, core, and tackle. The slings are shown

here wedged from the bottom plate J to the beam or cross-bar, which, of course, is not done until the mould is rammed up. When the mould is lowered over the core and set to the loam guides provided between the outside of the brickwork of the bottom flange and the cake-plate, the bolts holding the mould together from A to B may be removed for convenience of ramming the mould with suitable rings outside, from the bottom plate.

Fig. 3 shows the mould-board set to the bottom plate in the pit, and a section of the wall built, with binders C and D, and bolted from cake-plate A to top ring B for lifting. Fig. 4 shows the core-board set.

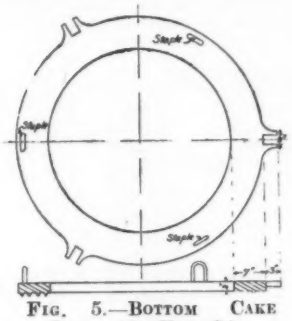

Fig. 5.—Bottom Cake Plate (A, Fig. 2.).

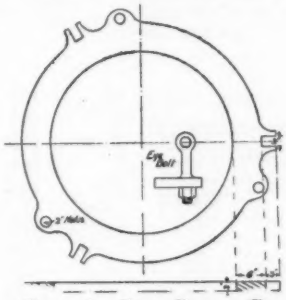

Fig. 6.—Top Ring (B, Fig. 2).

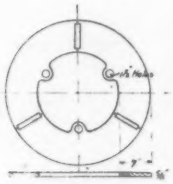

Fig. 7.—Core Binder (F, Fig. 2).

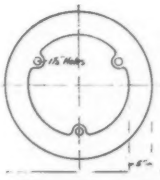

Fig. 8. — Top Plate of Core (G, Fig. 2).

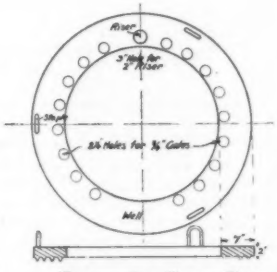

Fig. 9.—Top Cake Plate (H, Fig. 2).

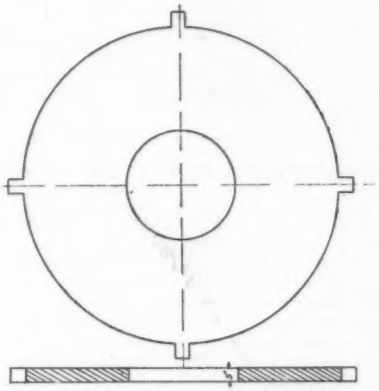

Fig. 10.—Bottom Plate (J, Fig. 2).

This board is stationary; the core revolves, and also the core wall of brickwork with binders E and F to stay the brickwork.

Fig. 5 shows in plan and section the bottom cake-plate, or ring A, which is provided with 1-in. long prods. The dimensions of bolting lugs and the thickness of plate are given. Fig. 6 shows in plan and section the top ring B, with lugs for bolting and

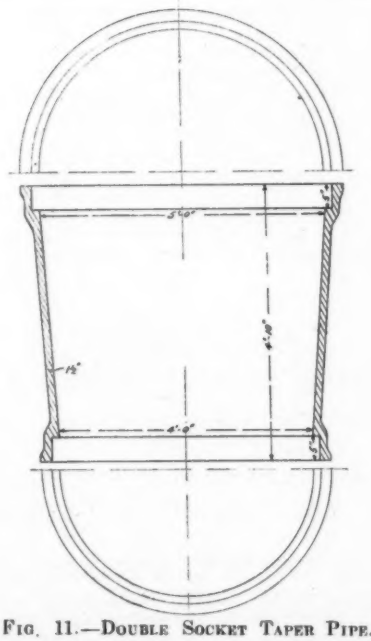

Fig. 11.—Double Socket Taper Pipe.

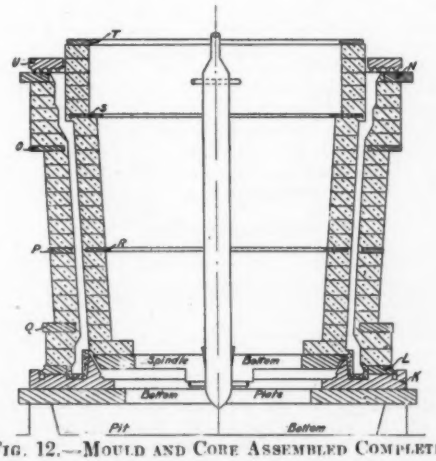


Fig. 12.—Mould and Core Assembled Complete.

holes for lifting. The dimensions are given, and also the eye bolt through the lug is shown.

The mould binder, C, (Fig. 2), is 4½ in. wide and 1 in. thick, and is split in two and held together by two small cramps, when on the brickwork; and the mould binder, D (Fig. 2), to carry the brickwork of the socket is split in two and held together similar

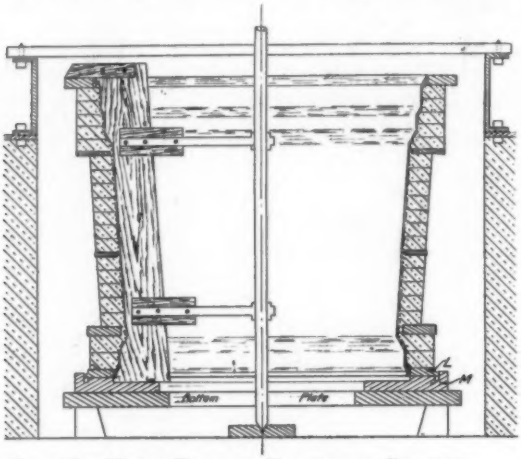


FIG. 13.—MOULD BOARD IN POSITION ON STRIKING PLATE.

to binder C, but is wider (7 in. by 1 in.) on account of the thicker brickwork it has to carry.

The core binder E (Fig. 2) is similar to that used for flange-pipes with branches (see FOUNDRY TRADE JOURNAL, February, page 86, Fig. 9). It is partly cut through in four places, and after the casting is poured and set, the key-piece is broken through and falls inside. The brickwork is then cut down to allow contraction, and afterwards the other lugs are broken, so that the contraction will be uniform. The size of this binder is 5½ in. by ⅝ in. Fig. 7 shows binder F, which carries the brickwork of the core socket. It is split right through in three

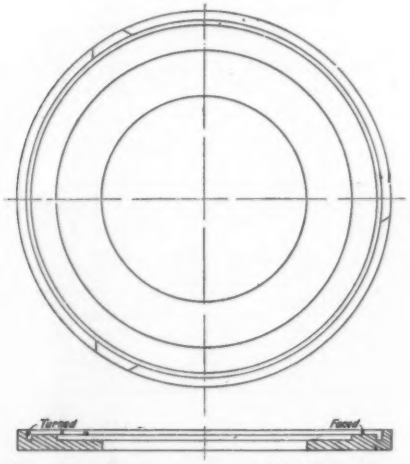


FIG. 15.—STRIKING PLATE (M, FIG. 13).

places, and is laid on the brickwork, as shown in Figs. 2 and 4. When easing for contraction the whole of the brickwork forming the core socket is removed down to the plate; the segments are then lifted out with a hook by the holes provided and can be used again for the next core. The outer edge of the under side of the segments is roughed, and small holes are cast in to carry the loam.

Fig. 8 shows the top plate of the core (G, Fig. 2)

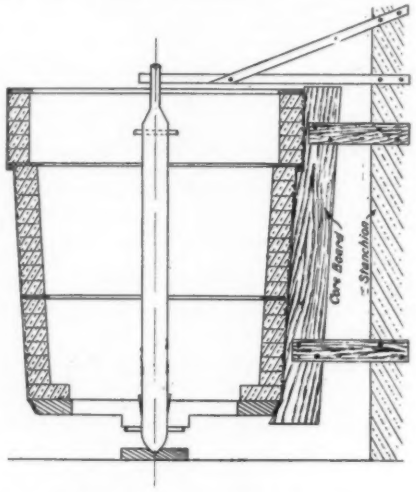


FIG. 14.—CORE-BOARD SET, AND SECTION OF CORE BUILT.

which keeps the top brickwork intact and on which the core is packed down from the beam or cross (see Fig. 2). This plate is put on the core after it is lifted away from the spindle arm. Fig. 9 shows the top and closing cake plate (H, Fig. 2), which is prodded one inch long and passes over the socket of the body core, closing in the mould. From this the mould is packed from beam to bottom or foundation plate (see Fig. 2). Fig. 10 shows the bottom or foundation plate (J, Fig. 2).

The methods of procedure in making both core and mould are similar to those described in previous articles, and need not be again repeated.

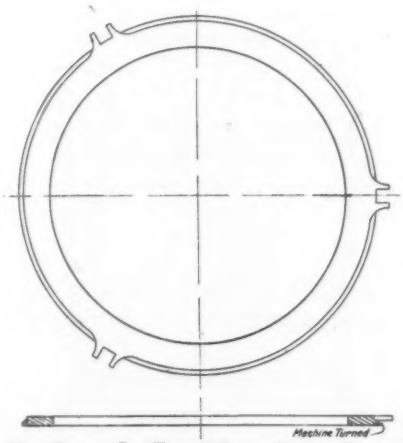


FIG. 16.—PLATE L (FIG. 13) TO CARRY BRICKWORK.

### Double-Socket Taper Pipes.

The procedure in moulding this casting is coupled with that for the flange and socket pipe, owing to a similarity; for while it is dissimilar in many respects,

a description of the two together avoids some repetitions.

Fig. 11 is a sketch of the pipe, with dimensions. Fig. 12 shows assembled the complete mould and core before ramming. It will be noted that the core of the bottom socket is formed by a cup, or socket

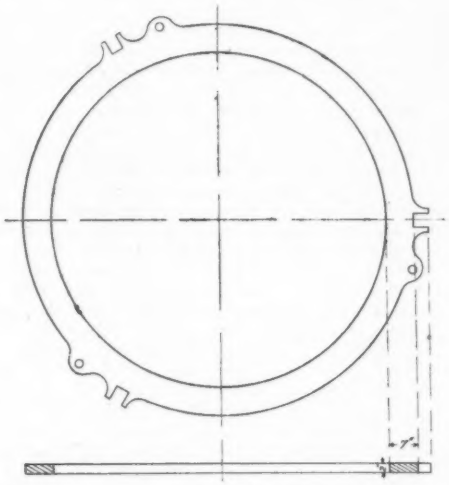

FIG. 17.—TOP MOULD RING (N, FIG. 12).

plate (K, Fig. 12), which is swept separately and into which the body core rests.

Fig. 13 shows the mould-board in position on striking plate (M, Fig. 13). This plate is necessary for correctness in setting the mould board and the ring (L, Fig. 13), which carries the brickwork. Fig. 14 shows the core-board set with the spindle and spindle bottom. It will be seen that the top end of the core is similar to Fig. 4 in the other casting, except that the taper is reversed. The bottom end of this core, as stated, fits into the cup or socket plate, forming the socket core. Fig. 15 shows in section and plan the striking plate M. It may be stated here that when only one or two castings are required, to avoid the expense of making and machining this plate, the seat and guide can be moulded in loam, and thickly coated with gas tar, and when dried iron bearings fixed in three places for ring L to rest upon; but the iron plate is the safest and most accurate way of working.

Fig. 16 shows the plate L, which carries the brickwork from the bottom of the socket. It rests iron to iron when in position on the striking plate M, and

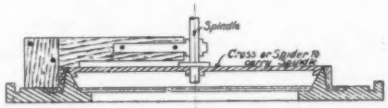


FIG. 19.—CUP PLATE K, WITH STRIKING BOARD SET.

its outside diameter is turned to fit the inside diameter of guides on the striking plate, both being machined. Fig. 17 shows plate N, which is the top mould ring under the closing cake plate. Plates M and N are bolted together as in the other casting, but the bolts are not shown in this case. The whole of the mould is lifted by eye-bolts as before.

Fig. 18 shows the cup, or seat plate K. When this has been struck up with a special board, dried and dressed, it takes the place of the striking plate M, that is, after the mould has been lifted, dried and dressed. The guides on the striking plate M and the cup plate K are the same, hence ring L lifts both. In this case the mould is lowered on the cup plate first, and the core lowered afterwards and centred.

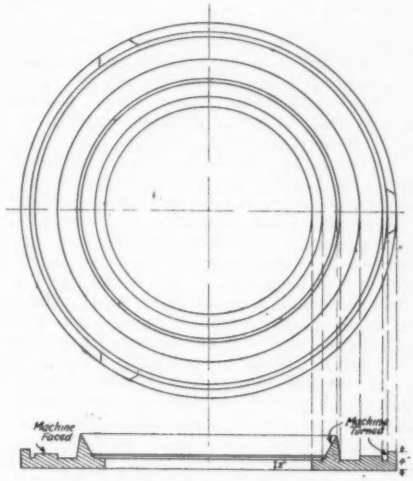


FIG. 18.—CUP OR SEAT PLATE (K, FIG. 12).

The following letters, except as to sizes, correspond to the tackle lettered in the drawing of the previous casting:—Mould binders O, P and Q are the same as D and C in Fig. 2; core binders R, S and T are the same as E, F and G in Fig. 2; top cake-plate U is the same as H in Fig. 2.

Fig. 19 shows the cup plate K with striking board set. The roughing loam is a strong clayey mixture, and the finishing or striking loam is mixed with gas tar, which makes a hard resistent socket core, which is necessary owing to the drop and beat of the iron when pouring.

## American Foundrymen's Convention in 1913.

At a recent meeting of representatives of the American Foundrymen's Association, the American Institute of Metals, and the Foundry and Machine Exhibition Company, it was decided to hold the 1913 Convention of the allied foundry organisations at Chicago, on October 14, 15, and 16 next. The Hotel La Salle has been retained as the Association Headquarters, and the business sessions will be held there. It is 12 years since a foundry convention was held in Chicago, the previous one being in 1901, when Dr. Richard Moldenke was elected as Secretary of the American Foundrymen's Association, a position which he has filled continuously ever since.

THERE was a large attendance of members of the Sheffield Society of Engineers and Metallurgists at a meeting held at the Applied Science Department of the University on February 24, when Dr. F. Rogers delivered a lecture on "Microscopic Effects of Strain in Metals." Mr. Arthur Balfour occupied the chair. It was subsequently announced that Mr. John Little had been elected a member of the Council, and that Mr. A. Balfour had been appointed to represent the Society of the International Congress of Mining, Metallurgy, etc., to be held in London in 1915.

# Everyday Difficulties in the Foundry.

By E. Smith.

At a meeting of the Newcastle-on-Tyne and District Branch of the British Foundrymen's Association, held in Newcastle on Saturday, December 28, the President (Mr. R. Wallis) in the chair, a Paper on "Everyday Difficulties in the Foundry" was read by Mr. E. Smith, of South Shields.

Mr. E. Smith, in introducing his Paper, said that perhaps the first difficulty encountered in the foundry was one of construction. If the building were properly considered before its erection, care would be taken that every commodity required for the work done was placed as close to the department as possible. The loam mill would not be put at one end of the shop and the loam floor at the other. Height of building was a great asset, and enabled the foundryman to turn boxes over with little difficulty, to cast high jobs, and to get impure air away quickly. Then as to light, he had seen many otherwise good foundries spoilt and working at a great disadvantage for want of light. Artificial light was neither so good nor so cheap as sunlight.

The next difficulty which often troubled the founder was badly made patterns. He had seen scores of deep patterns with no draft whatever, and which when drawn from the sand, left very little impression of the shape of the mould required. The attempts of a pattern-maker to make a strong, smooth pattern counted as nothing if he constructed patterns which would not draw well. Many difficulties might be obviated if a little talk on the subject was indulged in between the pattern-maker and foreman moulder before any new design of pattern was made. Also, care should always be taken to mark carefully, or give clear instructions, as to whether the castings were to be machined, in order that those parts should be cast downward if possible.

Boys were often a great deal of trouble in the foundry, and unless a man were set apart for their training, and they were kept well in hand, he was inclined to think that they were more trouble than they were worth. But he supposed it was necessary to look ahead and remember the future success of their trade depended on the progress and ability of the lads.

The next difficulty was the men. If only first-class moulders were employed, the difficulties in the foundry would be greatly minimised; but there were very few moulders to whom a job could be given with confidence that it would be completed satisfactorily. In the meantime it was necessary to make the best of the material at hand, and lessen the difficulties by giving the men work they could do and keeping them at it. It was better to let a job wait a few days, if possible, and then place it in the hands of a man who could do it right.

The greatest difficulty was an everyday occurrence in many foundries, namely, that of having bad castings. There were so many causes for that, that he could hardly enumerate them. Buckling, often caused by weakness of the metal; cross blowing, caused by air passages being choked; castings rough and uneven, caused by badly finished and blacked moulds; bad moulds, often caused by improper handling of tools. Bad castings were often the result of mental errors; and yet little attention was paid to the all-important subject of learning to think properly. Perfection in moulding could only be reached through strict attention to trifles. Moulders should not take chances; they should always err on the side of safety, and if they were not sure about any particular part of a mould, they should secure it beyond question.

More care should be taken in every shop with regard to the core-making branch of the work. It was necessary to see that the vents were opened in dry sand, and in loam moulding to have the moulds well dried. More castings were lost by under-drying than by over-drying. Many castings were lost because of dirt getting into them while casting, more than perhaps was imagined. Moulders seldom saw the importance of making a good well-gate to hold the metal and keep the dirt out while the iron was running into the mould. Too often he had seen saucer-like gates that would not hold any metal; many good moulds had been spoiled for the sake of spending a few minutes extra in making a decent well. Deep castings were best poured from the bottom, as there was then no agitation against the side of the moulds, and they were not likely to disturb the face and scab. There was also the very important and much-neglected use of feed runners in heavy work, the judicious use of which would make sound what would otherwise be drawn castings.

Then there was the cupola. Here often a lot of trouble arose. The working of the cupola required careful watching, for from very simple causes the metal might be too dull, too soft, too hard, or otherwise unsuitable.

The difficulty of having different qualities of scrap to work with made the mixing of metals a difficult problem. It would not be wise to give any fixed rule with regard to the amount of coke to be used per ton of metal; there were so many varying conditions in different foundries. What would give good results in one case would be absolutely disastrous in another. The kind of coke used, the formation of the cupola, the pressure of the blast and the metal to be contended with, together with the castings made, all were against the formulation of any fixed rule, and the foundry which tried to imitate another plant would often involve itself in trouble, and learn that the old and tried method gave, after all, the best results. He did not suggest that improvements should not be made, but that it should be done gradually and with caution. If it was found that too much fuel was used, it should be reduced day by day, or the charges increased until the best result was got. Excessive fuel meant slow melting, and more wear and tear to the furnace lining. To allow the iron to stand awhile, provided the mould was hot enough before pouring, would have a good effect and allow the gases and impurities to rise and escape.

He considered that iron did not become mixed in the cupola so well as in the ladle, because the weight of the full volume of metal plunged into the bottom of the ladle would have a better mixing effect than the trickling down of the iron in the furnace.

The question of why a casting cracked in certain places had often been looked upon as a difficult problem. Unequal thicknesses and the design of castings were usually the causes, but, of course, a poor class of iron would often crack where a good strong iron would stand. Cores would sometimes prevent the free contraction of a casting, and cause

trouble in that respect. Above all it should be remembered that a thin piece of iron would contract more than a thick piece. Massive castings were also subject to internal and external strain. He thought the purer and better the grade of iron used, the less would be the contraction experienced. In conclusion, the speaker remarked that the foundryman might exercise the greatest care and watchfulness at every step, but if only one small point was overlooked in the numerous processes leading up to the final operation of casting, the omission probably would not be found out until it could not be rectified. The worst feature was that a piece of work could only be done once. A commercial man might correct his correspondence; a joiner or cabinet-maker could replace a spoiled piece of wood; in fact, almost every branch of mechanics could replace or alter any faulty part of their work, with the exception of the moulder. On that account alone, foundrymen deserved a good deal more consideration than they usually received from those who had the power to reject castings.

### Discussion.

Mr. Gallon remarked, in reference to what Mr. Smith had said about the pattern-maker, that the pattern-maker was a man of great ideas; he thought that if he did his work well, made it beautiful of shape and a little bit bigger at the bottom than the top, he had done all right. But it was not all right; that was not intelligent working to begin with; also, the pattern should have a little draft on it wherever it could possibly be got. With regard to the foreman, he ought to at least know as much as the cleverest man under him, and, if possible, a little more. Speaking of core-makers, he instanced the inadaptability of some, and remarked that there was too much specialisation in the foundry—a man was kept too long at one thing. Apprentices under training should be given a turn, if possible, all round. He agreed that there were many castings spoiled in the running. He believed that one could often get as good a casting by having the runners and gates as heavy as it was possible to get them as by feeding them. He did not think that that rule would hold good for 20-ton cylinders and 10-ton condensers, and such like, but for small jobs. In reference to the cracking of castings, he believed they would have fewer cracked castings if they could leave them longer in the sand. If stove room were available the difficulty of cracked castings would be removed by putting them into the stove.

Mr. Patterson said that perhaps no difficulty appealed to him more than that arising from the very curious jobs one had sometimes to cast. The great difficulty in keeping the mould uniform in those castings was one which would have appealed to everyone connected with the production of iron castings. Mr. Smith had not mentioned the receiver of the cupola. Personally, he found that was of considerable value indeed. No matter how well the cupola were charged there would be differences in the metal as it came down. The uncovering of castings in order to cool them more uniformly he believed could accomplish a good deal, and also the use of chills in certain parts of castings in order to get them to cool more quickly in those parts. The lecturer had said that the boys were more nuisance than they were worth. He did not agree. He had seen some lads a few days since doing capital work.

Mr. Henderson said that with regard to the boys, the future of their trade depended upon the boys, and that was a very vital thing which foundrymen ought to take up in a very definite way. Regarding the class of boys they got in their foundries, it was admitted amongst themselves now pretty generally that they did not get the best, and the reason assigned was the uninviting appearance of a foundry. But why was the foundry uninviting, and what could they do—what must they do to make the foundry more inviting? They must have it in better order, and generally of a better appearance altogether. But that would increase the expense and would necessitate increased prices for their work. He would also like to put in a plea for dull lads. As he got older he found himself having more and more patience with lads, one of the reasons being that he had had it forced upon him that some lads opened out very slowly; nervous lads came into the foundry and probably spoilt a mould, when they got such a shaking up that they did not recover themselves for a long time. If one had patience and just spoke to them and let them learn, he believed that very often those lads who tried one's patience so much at the first, would reward one well for the care bestowed upon them. He thought they ought to look at their lads from a human point of view. Some were very nervous, and it took them a lot of time to get accustomed to foundry conditions. With regard to mixtures, the foundry was at the mercy of the blast-furnacemen. The thing was how long were foundrymen going to acquiesce to that. They would have to put pressure on the blast-furnacemen and call for iron up to a standard, up to analysis; then they would get something like uniformity. On the question of charging, there was a very interesting article in the December issue of the Foundry Trade Journal with regard to light charges, which commended itself to him. Perhaps some of the members had read it, and it would be interesting to know what their opinion was, whether it was better to have light charges or heavy ones.

Mr. Paulin said he spoke as an engineer who had a certain amount of sympathy with pattern-makers. He had seen splendid patterns sent into the foundry, and though it was perfectly obvious the way the draft was made, they had been moulded upside down, or sideways, or so that with, say, a wheel, the teeth were sticking out obliquely; and that sort of thing was done in spite of the fact that plates were put on the other edge. He would admit, of course, that there were cases where patterns could have more strip, and particularly where there were sharp corners—inside corners where a flange ran towards a boss and formed an acute angle—it would save a lot of work. He had also found that many complaints that were made by foundries arose from the fact that foundrymen generally did not try to keep up with what was going on in the engineering shop. Many of the bad tools that were used in foundries could be done away with altogether. Rather than drill a hole the moulder would go to any amount of trouble to core it out. In regard to the question of cracked castings, the trouble began with the stress set up between thin and thick parts; the thick part fed the thin part, and as the thin part set the thick part was still so hot that the pull on the thin part produced a stress. He had seen chills used on ordinary castings, especially on very hot bosses in wheels. The one great difficulty was that generally just where the joint was made between the chill and the mould, there would be formed a small fin of metal which was exceedingly hard, and which almost became white iron. If that had to be machined in the region of the fin—it was generally on account of the machining that the chill was put there—great difficulty was experienced in getting rid of the fin. It was possible, at times, to snap it off, but that did not get rid of the trouble. He was afraid there was rather too much made of the importance of the analysis of the pig. When it was considered that in many of the mixtures half of the material was scrap, the analysis of the pig did not count for much. He had seen disaster follow through perhaps a bit of

piping which had been used in chemical works, and a bit of the chemical having been left in the pipe.

MR. WEIR said the last speaker had, in a way, defended the pattern-maker. Very often one found the pattern-maker sending the pattern to the moulding shop to be moulded according to his (the pattern-maker's) method of moulding, which was contrary to the principles of iron founding.

MR. J. SMITH said in regard to cracked castings, some years ago he had experienced considerable trouble in this direction, and had finally come to the conclusion that the design of the job was at fault. Another firm making similar castings another way had not one waster, and he thought that was clear proof that they were to look to the design for the fault of that job. In regard to the mixing of metals, he believed in letting well alone.

MR. CARMICHAEL said he sympathised with the idea of making the places clean, and encouraging the boys, but the difficulty was the expense. He would suggest that the apprentices should be bound in the same manner as engineers, so that they could not leave as soon as they were trained for the foundry's work.

The CHAIRMAN said that Mr. Smith had mentioned light in the foundry. If they took any foundry of any age at all, it was about the most dismal and dark and unhealthy place, and the least conducive to good work of any workshop that could be picked out. Why foundries should be built practically without light or windows he did not know, but, generally speaking, that was the rule with old foundries. In modern foundries, the people who had had something to do with the structure had realised the value of daylight. The question of light in the foundries had assumed a very serious aspect, so serious that the Home Office had taken it in hand, and if they had to do all that the Home Office would have them do, it would mean that all the foundries in the country would have to be rebuilt. He did not think, however, that they would be compelled to go quite so far as that. He did not suppose the question of patterns would ever be solved. But there was a middle line, and where a firm was running its own pattern shop and foundry, they began to know something about the two working together. The treatment of patterns by the foundry also required some give and take. There were certain patterns on which a great deal of money had not been spent, and it was sometimes only reasonable in the interests of the moulding that those patterns should come back badly damaged. The suggestion of Mr. Smith that in the foundry a special man should be put in charge of boys was a practical one, and he thought any foundry would be well repaid if the apprentices were under the charge of a man whose business it was to see that the boys' fault and errors were corrected as quickly as possible. If they could get people who were interested in works to understand that the moulders trade was a skilled one, and get people interested in it, then they would get their boys to come to them; but they must first get them to understand that the skilled moulder was an artizan of no mean calibre, and in that direction they would find that the old saying, "The world takes you at your own valuation," had got a good deal in it. In regard to mixtures, so long as scrap up to 50 per cent. of the mixture was used, there was not much use talking of what the final analysis of a casting was going to be. There was a growing feeling in the metallurgical world at the present moment that the deleterious effects of phosphorus had been very much overrated. The reason for that was that they could, with a high phosphorus iron obtain any sort of test. Dr. Stead had said only recently that the opinion on the effects of phosphorus on cast iron was slowly but surely undergoing a change, and the bad effects had been in the past overrated. Personally he (the Chairman) was rather inclined to doubt that, and thought they should be very careful.

The charging of the cupola, continued the Chairman, had possibly something to do with uncertain results. If the charges were irregular, then the melting would be irregular also, and the question of remelting was, of course, one of cost. With regard to letting the mould stand before casting, that was a question which, of late, had received some consideration, but it was questionable whether crystallisation was effected by cooling before the first recalescence point was reached. It was not a question whether the rapid cooling from the point when the metal began to get pasty down to its final setting affected the final crystallisation: the more rapidly it was cooled the finer would be the crystallisation, and the stronger and cleaner and denser would be the casting. The point was whether rapid cooling from the time the metal was melted down to that point did also affect the final crystallisation. He was rather inclined to think it did.

MR. SMITH, in reply, said the only question to be answered was that by Mr. Henderson, who said he was not quite clear about buckling being caused by weakness. His (Mr. Smith's) idea was that when a weak loam was used, it gave, and the metal got underneath and lifted it partly on an angle, which was the cause of buckling.

## British Foundrymen's Association.

### Annual Dinner of Halifax Branch.

The second annual dinner of the Halifax Branch of the British Foundrymen's Association was held on January 25, about 65 members and visitors being present, presided over by Mr. Milligan in the unavoidable absence of the President (Mr. H. Campbell).

After the loyal toast had been duly honoured, the CHAIRMAN proposed the "British Foundrymen's Association." He said that this Association was founded for the mutual betterment of foundrymen, and he felt sure that it achieved its object. Ideas were given and taken which were bound to materially help them in their daily work. Locally, the Halifax Branch was thriving, having a membership of 130, and a great deal of good work had been accomplished during the two years the Branch had been formed. He thought that the Association should tender their thanks to the Halifax Corporation for putting at their disposal the comfortable room at the Technical College for the holding of their monthly meetings.

MR. SMITH, responding, said the Association had done much to break down the conservativeness of the British ironfounders, and this in itself was a result well worth striving for.

MR. J. CROWTHER, B.Sc., in proposing "The Town and Trade of Halifax," gave a good report of the trade of the town during the last two years, showing the general prosperity of the varied trades of the district. He also mentioned the municipal undertakings, and said he thought the town of Halifax got good value for the money expended on schools.

MR. HOWARD CLAY, in replying, said Halifax, with two exceptions, had perhaps been lacking in enterprise, the exceptions being the Akroyds and the Crossleys. The very serious depression in the machine-tool trade was the cause of emigration of a great number of our intelligent men. Now, during a trade boom, expansion was impossible in some of the trades because of the shortage of labour.

A musical entertainment during the evening was provided by the Kingston Glee Union.

# The Metallurgical Work of a Motor-Car Factory.

(*Continued from page* 110.)

As before indicated, the heat-treatment of materials is an important feature of the Daimler Company's operations. Primarily, heat treatment is for the purpose of relieving the metal of internal stresses. This does not apply to castings only; forgings also are strained unequally by the dies and hammers, so that they need the influence of a high temperature to put them into a fit condition for use. Annealing is also carried out with the object of producing a fine uniform grain size, by heating the steel to the temperature of the critical point, $Ar_3$, or a little above it, whereby a complete recrystallisation is produced. Annealing, then, consists in heating a casting up to a temperature known to be the best,

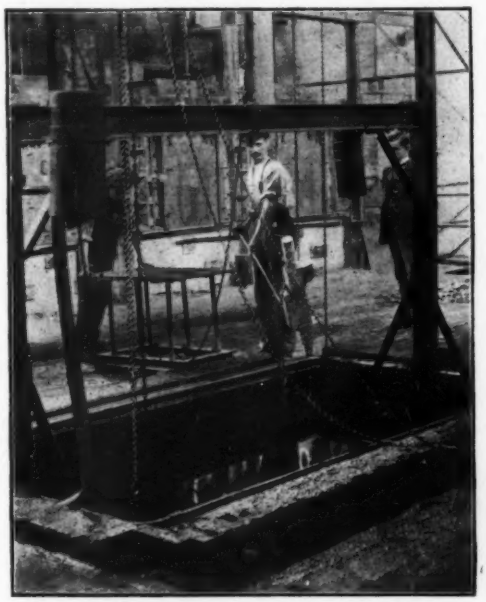

FIG. 7.—OIL BATH FOR QUENCHING HEATED FORGINGS, ETC.

FIG. 9.—FRACTURES OF CASE-HARDENED STEEL PARTS.

for such time as is necessary for an internal readjustment of strained portions, and the production of a fine and uniform grain. All steel castings are subjected to the treatment; possibly, if steel were an absolutely homogeneous material like glass, the annealing temperature would be a matter of small importance, likewise the duration of the process, but as the structure of steel is not, to the microscope, absolutely homogeneous, the problem of correct temperature and time assumes much complexity.

The test of a piece of steel in the state in which

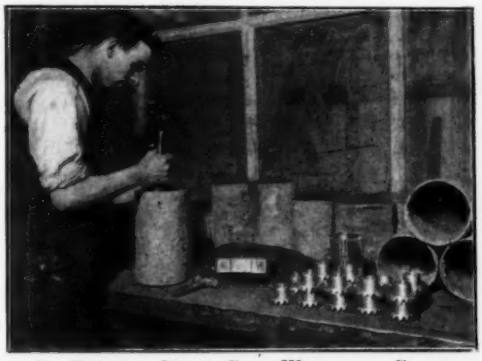

FIG. 8.—PACKING SMALL GEAR WHEELS IN COMPOUND FOR CASE-HARDENING.

it is received is very often misleading. Mere differences in processes of manufacture may give to an inferior material the apparent properties that one associates, for instance, with nickel or nickel-chrome steels. Such improvement may be due to mechanical work having been performed on the material by rolling or drawing, and the enhanced test value as the result of "working" is a well-known peculiarity of almost all metals. Advantage is often taken of it with mild steel, upon which mechanical work produces, amongst other desirable properties, that of easy cutting. But however valuable in some respects this artificially induced strength may be, it is frequently misleading to those who are taken unawares, and buy such metal with an incomplete knowledge of its true properties. Annealing is the proper corrective to apply to such materials. Accuracy is, of course, only obtainable by the application of some means of temperature indication.

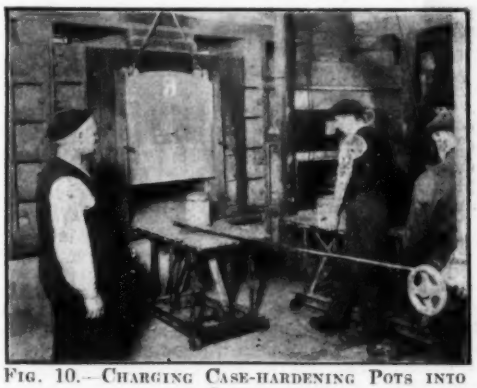

FIG. 10.—CHARGING CASE-HARDENING POTS INTO OVEN.

Nor is this wholly effective unless the peculiarities of the particular material undergoing treatment are known.

The functions of the Daimler Company's "steel kitchen," however, are not confined to annealing. Some of the forged components, such as nickel-chrome or chrome-vanadium crankshafts, undergo a more complex treatment. The steel parts arrive in batches from the forge, all with the same complaint, crystallinity. They are tested in each case by the Brinell machine, for there are varying degrees of crystallinity, and it would not do to give them all the same treatment. Besides this crystallinity induced at high temperatures, another feature of metallic articles that have been forcibly pressed into shape is the flow of grain, which is noticeable whether the work is performed with the metal hot or cold. Fig. 7 shows the oil bath in the heat-treatment department, with a rough crank forging about to be quenched. The oil is kept at a uniform temperature by constant circulation through a cooler.

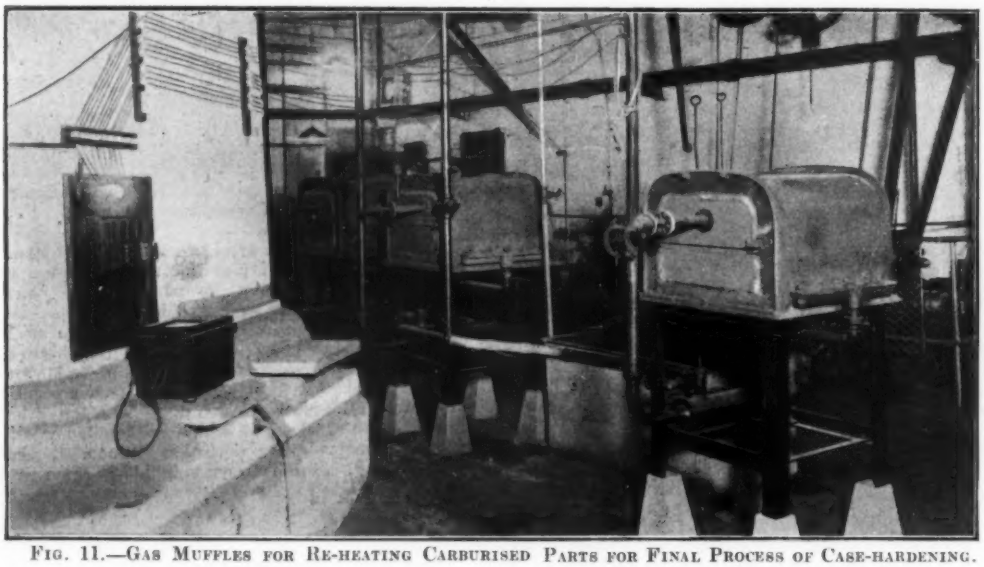

FIG. 11.—GAS MUFFLES FOR RE-HEATING CARBURISED PARTS FOR FINAL PROCESS OF CASE-HARDENING.

### Case-Hardening.

The object of combining a hard shell with a softer core is to provide in one and the same member a good wearing surface and sufficient toughness to resist shock. Extreme hardness, such as the exterior of case-hardened parts possesses, is essentially associated with brittleness, while extreme toughness implies a low-carbon steel, which can never be made as hard as a steel that has a high carbon content.

A case-hardened part, then, is one possessing the qualities of both high- and low-carbon steels in different portions of the material. The outer shell is high-carbon steel and the core low-carbon steel. It remains, therefore, to consider how this curious state is produced. The starting material is a soft or dead-mild steel, which, in a clean state, is packed in a wrought-iron pot with a case-hardening cement, generally some organic or nitrogenous material like charred bones or leather, with or without a chemical addition such as an alkali. In some cases hydrocarbon oils are added, or some oily vegetable materials that emit a smoky flame early in the operation. For special purposes, the yellow prussiates are employed; but whether such are added or not, it is certain that members of this cyanogen family are formed in the operation and assist materially in the carburising. Mention may be made of the almond-like smell, characteristic of prussic acid, that is often emitted from a newly-opened case-hardening pot. The amount is not dangerous, but their poisonous nature is at least one of many grounds ofr not recommending the use of specific cyanogen compounds in the mixture.

The purpose of the process of case-hardening is to cause carbon to be introduced into the metal; but carbon does not permeate the iron by its own agency alone. This can easily be seen by packing an article in practically pure carbon, say anthracite; no matter how prolonged the subsequent heating, there will be scarcely any case-hardening effect. A common feature of many casing mixtures is the inclusion of nitrogenous matter of some kind, and nitrogen appears to have a catalytic action in the production of the previously mentioned cyanides, which in a gaseous form permeate the metal and leave only the carbon behind. The permeation of iron is rather difficult to understand, although it has long been known that carbonic oxide has the property of passing through the metal at high temperatures. Many authorities consider that this gas is alone responsible for the cementing or case-hardening of soft iron and steel. The action of the carbonising gases probably takes place in stages, a thin skin being formed on the outside and the carbon gradually soaking inwards.

The following gives a rough idea of the percentage of carbon found taking $\frac{1}{100}$ in. cuts inwards from the outside, of a case-hardened piece:—No. 1, 1.20 per cent.; No. 2, 1.20 per cent.; No. 3, 1.02 per cent.; No. 4, 0.90 per cent.; No. 5, 0.78 per cent.; No. 6, 0.66 per cent.; No. 7, 0.54 per cent.; No. 8, 0.34 per cent.; No. 9, 0.18 per cent. Further in the original material is unaltered and contains about 0.1 per cent. carbon.

But to return to the part being case-hardened. It is placed in the pot and packed round with a suitable mixture, certain parts that it is desired to leave soft for machining being protected by clay from the carburising action. The pot, carefully sealed, is then placed in a gas-fired oven or muffle, where a

reducing atmosphere is maintained as far as possible. This reducing atmosphere, being free from excess oxygen, is incapable of forming scale or oxide on the surface of the metal. In the oven the pots are raised to the requisite temperature, and maintained at this heat for a period depending on the character of the part and depth of case required. The regulation of this temperature is quite as essential as in the annealing process, and much depends on the correctness and constant standardisation of the pyrometers used. This process completed, the pots are removed to cool unopened, and if the process has been entirely successful, the parts when removed possess a fine silvery-white appearance. A spotted or dull surface is a sure sign of bad work.

The case or shell of the metal is still soft, being only carburised, as distinct from hardened; in other words, it is like a hard steel in the unquenched or soft condition. Advantage is often taken of this soft state to machine off the carburised shell from any parts that are required to remain soft. Extra metal can be left on in the first instance for this purpose, and this procedure is sometimes more convenient than protecting local parts with clay

The next process is to harden the case by re-heating and quenching. This varies considerably with different components. It is sufficient here to consider, say, a piston pin. Merely quenching at the temperature necessary for the outside (1 per cent. carbon steel) will not refine the core grain in the least; a low-carbon steel always requires to be quenched from a higher temperature than a high-carbon steel, and it is, therefore, necessary to subject the pin in question to two separate operations :—(1) Heating up to a high temperature and quenching in water to refine the core grain; and (2) heating up again to a somewhat lower temperature that is suitable to the high-carbon case, and again quenching. This leaves the case hard while the core is in a fine tempered state, and the pin is then in a finished condition, ready for despatch to the machine shop for grinding.

The appliances used for this reheating are small muffles, something like the carbonising chambers, but in miniature. They are seen in Fig. 11, on the left of which will be noticed the pyrometer switchboard from which the temperature of each is regulated.

The surface of the case-hardened parts is now so hard that it will repel the attack of a special file that will scratch glass, while its interior is tough and fibrous. Fig. 9 shows two case-hardened parts that have been bent under the hammer; the fractured surfaces reveal the brittleness of the hard shell while and fibrous core shows the tough character of the interior.

Taking next a gear wheel, this arrives from the forge as a black disc of metal of fairly regular external contour, but of irregular internal structure. It is first annealed to remove this weakness, and then sent into the workshops to be machined, afterwards returning to the "kitchen" in an apparently finished condition, except that there are no keyways. Also the boss and surrounding portions of the wheel are extra thick. Then comes the carburising process,

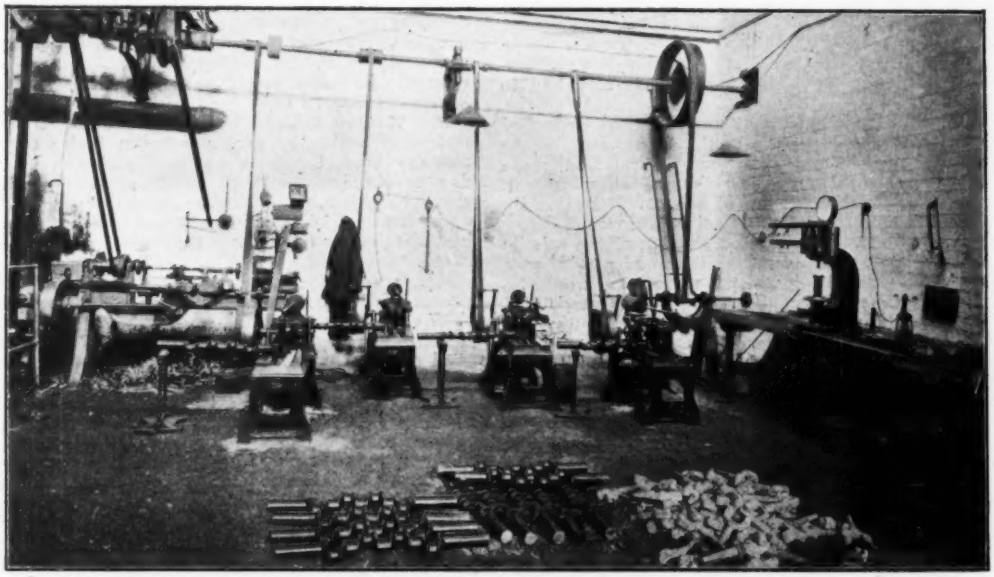

FIG. 12.—CORNER OF ONE OF THE DAIMLER LABORATORIES; BRINELL HARDNESS TESTING MACHINE ON THE RIGHT.

which is carried out as described for the piston pin, and the gear wheel goes back to the workshop again in order to have its keyways cut and the boss reduced to the correct thickness. This process cuts away the carbonised surface from those parts and prevents them from subsequently hardening. It is then returned to the "kitchen" for the last time to be re-heated and quenched, which operation differs from that performed on the piston pin, in that oil is used instead of water as a quenching medium. For components that are to be subjected to high stresses, oil is always employed, as it leaves the material less hard, but tougher.

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PLANS are being prepared for an extensive foundry plant to be erected at Hamilton, Canada, by the Hamilton Malleable Iron Company, Limited. The main foundry building will be 200 by 600 ft., and will contain four 15-ton melting furnaces, annealing furnaces, complete cleaning and finishing equipment and high-speed electric travelling cranes. Other buildings include a machine-shop, carpenters' and pattern shop, storehouse, pattern storage vault and office.

# Discussion on Foundry Work.

At a meeting of the Newcastle-upon-Tyne Branch of the British Foundrymen's Association, held on Saturday, January 25, Mr. R. Wallis in the chair, a number of questions were discussed.

### What Thickness of Loam should be put on the Rope Foundations of Spindle Cores.

Mr. Gallon, in raising this question, said that he had heard it stated that $\frac{3}{8}$-in. would do, and anything from $\frac{3}{8}$ in. up to $1\frac{1}{2}$ in. He had tried $\frac{3}{8}$ in. himself, but found it to be a failure. He thought there ought not to be less than 1 in. of loam around a spindle core, and one might go up to $1\frac{1}{2}$ in. with safety.

Mr. Smith said he did not think the question should be argued on a point of theory at all, as it was really a question of a practical core-maker finding out by his daily practice what thickness of loam he needed. As little as $\frac{3}{8}$ in. might do, but it depended entirely upon the pressure the core had to stand.

Mr. E. Smith said that a good deal depended on the size of the spindle used. If a small spindle were used, and a lot of straw had to be put on, there would be more loam required than if there were a big spindle nearer the size of the core. But really it was all a matter of practical experience.

Mr. Henderson agreed that the size of the spindle had to be taken into consideration. If a 4-in. core were swept on a 1-in. spindle, more loam would be required to give it solidity than if a 2-in. spindle were used. He also agreed that for light work as little as $\frac{3}{8}$ in., or even $\frac{1}{4}$ in. could be used. He had seen cores with only about $\frac{1}{4}$ in. of loam on the outside, where the straw had been packed carefully, and everything had been all right.

Mr. Paulin said that so far nothing had been said as to what size pipe should be used. He considered that the length had a lot to do with it. Take for example, a drum, with the core supported at both ends, and the stress of the metal in lifting tending to bend the core. The size of the pipe used should bear a certain relation to the upward pressure of the liquid metal at the centre, taking it as a uniformly distributed lifting effort.

The Chairman said that the question of the amount of loam required on a spnidle core was only one of the questions regarding that core. First of all must be considered what the core was for, and what it had to do. The core must be of sufficient strength to prevent the pressure of metal or any pressure coming on to it and disturbing or bending it. The tube was intended to give strength to the core, and to give free exit to the gases from it. The straw, or wood-wool, was a porous covering to allow the free passage of the gases from the surface of the core to the spindle, and the loam covering was a covering which must be strong enough to maintain the shape of the core when the casting was made. Therefore, to his mind, there could be no definite answer to the question of any particular thickness.

Mr. Gallon remarked that he thought the bigger spindle one could get into the core the better for the core.

### What is the Cause and Cure for Buckles?

Mr. Henderson said that this question was raised in the address they had last month. He thought the reason why a casting buckled, in the first instance, was that there was probably an excess of moisture. If it was a green-sand mould, the probability was that there was a hard spot, or it might be that just in that locality there was a knot of wet sand. But whichever way it was, he took it that what caused the buckling was either the gas that was generated in the process of casting, or the steam that was generated at the same time, and which had not got off freely enough; the probability being that when the hot metal came over the face of the mould, a thin film of the metal remained on the face of the mould, and underneath that the gas or steam was generated and could not get down through the metal quickly enough, and so raised these thin films of metal, bringing the sand or loam away with it up into the casting.

Mr. McLachlan said he did not think a dry sand, or even a green sand mould would act in that way under ordinary conditions. He thought the reason probably was that they had never got the cores properly dry. It also might be caused by a moulder in ramming his mould, striking the pattern with the rammer; he would make that part of the sand very hard, and this in process of drying might lift.

Mr. Paulin said he had noticed what might be termed a buckle by Mr. Henderson both in green and dry sand, but he would hardly consider it was due to the reasons given by him, namely, steam generated between the surface and the sand. The appearance of the casting after it had cooled gave him the impression almost that the sand had been lifted.

Mr. Edward Smith said he quite agreed that dampness would cause buckling, but he had found the chief cause to be weak loam.

Mr. Gallon said he had seen buckles both in green-sand and dry-sand moulds, and it was very difficult to say what the cause was. They might have a very large casting, and it would be good all over excepting in one particular place, that place having the formation referred to.

Mr. Henderson, in his reply, said that he believed that most moulds were rammed far too hard, and that often was the cause of buckling. He still held that the less clay there was in the sand, providing there was just sufficient to keep the mould firmly together, the less likelihood there would be of buckling.

### Smooth Skin on Green-Sand Castings.

Mr. Henderson, in putting the question, "How can we get in this district, the fine, smooth skin on green-sand castings which Scotch castings have?" said that it was a very interesting one, especially to the producer of gree-sand castings.

Mr. Smith said he considered there were better green-sand castings made on the North-East Coast at the present day than were made in any part of Scotland. He did not think that the Scotch castings were any better than theirs, as far as the green-sand work was concerned, and when they came on to heavy work they were quite equal.

Mr. McLachlan said he had made castings up to 5 tons and 6 tons, and had obtained a good skin on them. The sand made a difference; he had a Scotch rock that was second to none anywhere, and if that was mixed with certain parts of yellow loam it gave good results.

Mr. Gallon said that the same men who made the castings in Scotland made them here, and it must, therefore, be in the material; it could not be the men.

Mr. Carmichael said that in his opinion the difference was with the metal, not the sand. For instance, in Staffordshire, castings were made exactly the same as by the Scotch firms. If they took a

poor quality of metal, and got it burning hot, it would not flow probably the whole distance, but if they took a good iron and kept it in the ladle until it was apparently quite thick and cold, it would run quite freely.

The CHAIRMAN said there was no reason why castings in any district should not be made with the same skin as Scotch castings. The reason why they were not would probably be on account of the district in question going in more for heavy castings on which a fine skin was not required.

## HALIFAX FOUNDRYMEN.

At a meeting of the Halifax Branch of the British Foundrymen's Association, on January 25, Mr. Milligan in the chair, a discussion on "Foundry Problems" was held.

### Clean Castings.

MR. CARRICK, in introducing a discussion on the best method of procuring clean castings, said the call upon foundrymen to produce absolutely clean castings on the face side, had been one of the problems facing them for many years, but nowadays it was becoming quite a science, because it was not only the face side which was required clean, but castings were demanded which were totally free from specks. Certainly castings clean all over were better from a selling point of view. He himself was responsible for turning out hundreds of castings every week of this description. The old way of making sure that castings would turn up clean was to allow extra thickness, but the day for these methods was past. He then gave his opinion as to the best proceedure needed to obtain satisfactory results. In the first place moulders should not work their sand too wet; if they did, it was an utter impossibility to get a clean face, on account of the extra gases and the production of too much steam in the mould. In the second place he should always vent his mould well, a few extra vents never being wasted. He would also recommend, where convenient, the use of dirt runners; the style adopted in the foundry with which he was connected, was the swirl runner. Anyone who read the FOUNDRY TRADE JOURNAL would have seen many types of these runners. He would advise a few experiments, and each man could satisfy himself as to which was the most suitable for the work required. A very important point to note was the formation of the pouring basin; if it was made broad at the front and tapered off to the down runner with a round back, this would cause a whirlpool, and the dirt would be drawn down into the mould. The proper style of pouring basin was the one almost as wide at the back as the front, taking care that the back was straight and square. A pouring basin of this type caused the metal to lie steady with the dirt floating on the top. One point for foremen to watch was the temperature of the iron; clean, sound castings could not be obtained from dull, sluggish metal, and very often if this was not carefully watched, pellet holes would be found during the process of machining.

MR. F. BERRY said it was all very well advocating swirl runners, but they took up room, and many foremen liked to fill their boxes with castings and not with gates. He was amongst that class himself.

MR. J. GAUNT added a little to Mr. Carrick's exposition of pouring basins, pointing out that not only did the narrow taper style of runner cause a whirlpool, but should the mould require feeding it was very awkward, because there was no volume of metal where the feeding rod was worked up and down.

MR. CARRICK, in replying, said the dirt runners would do either in the top or bottom parts of the mould, but he used them in the top, and he also thought it was better to have a box with a few less castings in if they were all good and clean, than to pack the boxes and have half of them wasters.

### Pulley Troubles.

MR. LIMB then introduced a problem which had been sent by one of the members. The trouble arose through the springing of an 11-ft. pulley, which was split in the boss and fractured at the rim. The pulley had wrought-iron arms. When the fracture had been cut through in the machine shop, the rim sprung $1\frac{3}{8}$ in., and it could not be got back into position. The question asked was, what was wrong with the method of moulding or pouring. He said he first wanted to know whether the boss and rim were cast the same day, or if the rim was cast one day and the boss the next day. This brought the answer that both were cast the same day. He (Mr. Limb) said this made the solution quite simple. It was an impossibility to accommodate the greater contraction on the rim than in the boss, or to prevent the arms from buckling, if this method were employed. The rim should be cast one day and the boss the next day. If the boss was very heavy, he would recommend the additional precaution of wrapping the arms in wet sacking near to the boss when the boss was cast. This explanation met with the general approval of the members present.

MR. R. PICKLES next briefly discussed the question of test bars, giving some varied experiences in trying to bring castings up to the required standard to satisfy Inspectors.

### Tuyere Area.

MR. W. SMITH then introduced the question of "Tuyere Area" in relation to the diameter of the melting zone of a cupola, and referred to the Whiting cupola. The satisfaction given by this cupola, he said, was largely due to the arrangement and construction of the tuyere system, which was designed so as to distribute the blast most efficiently, carrying it to all portions of the cupola, where it would do most good under a reduced pressure and through an increased area, thus permitting the air to reach the fuel through an area nearly double that at which it enters the tuyeres, admitting the same volume of blast but softening its force. There were three rows of tuyeres, and the top row could be closed by means of an improved tuyere damper. The size of the cupola described was 6 ft. diameter, tapering down to 4 ft. 6 in. at the melting zone. The size of the tuyeres were as follows:—First row, 8 in. by 5 in.; second row, 6 in. by 4 in.; and the third row, 2 in. by 2 in. There were eight tuyeres in each row. Mr. S. G. Smith had stated that for cupolas 40 in. in diameter, 5 round tuyeres 4-in. diameter or equal to that area, oval shape, were correct. From actual experience he (Mr. W. Smith) could not say that 3 rows of tuyeres were a success. They were very faulty and took up too much space, for tuyere area only. He found that he could do better without the top row than with them, and 12 months ago he determined to make alterations. He made up the two top rows and placed a row 1 ft. lower down, belling the entrances. This made a difference in the rate of melting of 30 cwts. per hour. He said that their furnace had no receiver.

MR. S. G. SMITH remarked that the less said about test bars the better. All depended on the iron used. The article written by himself in the FOUNDRY TRADE JOURNAL, November, 1912, on cupola practice, was from actual experience. Three rows of tuyeres, he contended, were unworkable; two rows were less doubtful; one row with the right area was the thing. Some American firms were advocating continuous tuyeres for quickness and fluidity. It was not so much pressure as volume that was wanted.

# Pattern Making for Motor Car Work.

Before the London Branch of the British Foundrymen's Association, on February 14, Mr. J. W. Worrall, of Commercial Cars, Limited, Luton, gave an address on "Pattern-making," dealing particularly with those patterns with which he had been most conversant during the last seven years, viz., patterns for castings in connection with motor-car work. For the purpose of better illustrating his remarks, the lecturer had, with the kind permission of his firm, brought to the meeting a number of the actual patterns which had been in use in the foundry, and also other new patterns just prepared.

The first patterns dealt with were those for a ball-bearing crank case. The construction of the pattern and core-boxes was explained with reference to the patterns themselves. These are shown in Figs. 1 and 2. It was explained that an aluminium plate *a* was cast and fitted all round the joint of the pattern, making a strong, light and firm job, and providing, also, handles for lifting purposes. The ends of the pattern were feathered into the sides, so that if rapped they would be firm enough to withstand the effects. The magneto bracket *b* was of cast brass, filed up and fitted securely by screws and lugs carried right under the joint plate; and the timing-gear end *c* of the crank case was made in one piece, so that the centres were always constant, while also the core was certain to match same. The loose pieces *d* along the base of the case were dovetailed with ample angle to ensure that they would be left behind when the pattern was withdrawn. All the corners of the pattern inside were fitted with angle pieces *e* to strengthen the joints and keep moisture from hanging there.

The core-boxes for this pattern were an interesting feature, though simple in construction. They consisted of a frame *f* with all the parts fitted and assembled inside, so that when the frame was taken off all the sides *g* could be drawn away separately without any risk of damaging the core. The main feature of the cores made in this way was that they were all correct, as there was no necessity for dogs or screws. The frame was tapered to allow for fixing and removing, and also tapered in the correct direction, so that the core did not require to be turned over. These frames, it was explained, were easily replaced, and also took all the rough knocks and hard treatment in usage, store or transit. In the bottom core-box *h* a portion was left open for ramming and a stickle provided for finishing off. The joint of this core with the main core was governed by the angle of the web and face of the oil boat. The beads *i* in the two body cores were raised so that if they were not placed in quite correct position it would not be noticeable, as the thickness would appear on the surface.

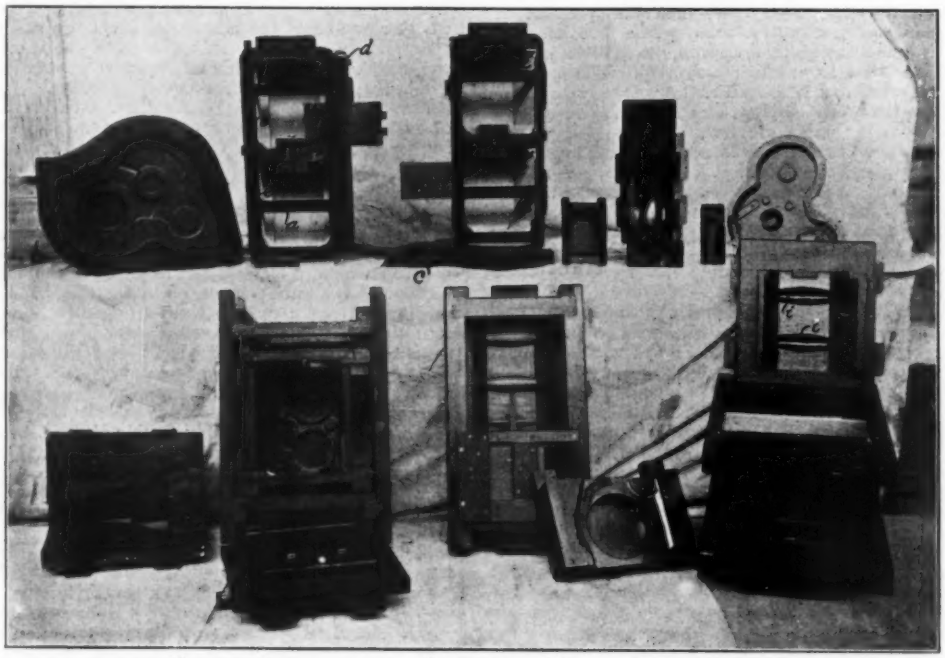


FIG. 1.—PATTERNS FOR A BALL-BEARING CRANK CASE AND COVER.

The next pattern discussed was for a water-jacketed twin cylinder for a motor car. The pattern and core-bores for this are shown in Fig. 3. Patterns of the design shown, said the lecturer, were best jointed in three places:—(1) The centre of the combustion head; (2) the centre of the water intake; and (3) the flange at the base of the cylinder. The joints of the cylinder patterns should have cast plates

fitted to take the wear and also to stiffen up the woodwork. The lecturer's practice was to cast plates for these, leaving a margin of about ⅛ in. of wood all round. These plates were made with hand holes for lifting the pattern, and also holes for rapping.

The space between the first joint *j* of this pattern and the exhaust could be fitted with a print, which would save the making of drawbacks and keep the joint flat. The fitting of the joint at that point made the moulding a good deal more straightforward, and the core *k* was an easy one to make. There was also a print *l* between the induction and the water intake, and this was necessary to secure accurate work. The last joint also was a plain flat joint for withdrawing the flange and fitting the cores.

The first core to be placed in the mould was the water-dome core *m*. The core-box for this was made with two loose metal pieces *n* to form the external part of the combustion chamber. This core-box was assist in lifting, and these have been found very beneficial.

Discussing generally the question of the patterns under consideration, the lecturer remarked that most of the special features pointed out in the construction had been favourably received by the foundries using the patterns. Regarding draught or taper, on the majority of such patterns it never required to be more than 1 degree (it was to be understood that the patterns were designed for standard work). He did not mean that the core prints should have only 1 degree draught, however, for they could well do with as much as 5 degrees; but for the pattern itself 1 degree was ample, seeing that the mould would clear the core by that 1 degree plus the thickness of metal. These remarks on draught, he stated, must be clearly understood to refer only to the patterns under discussion, since every pattern should be considered on its own merits.

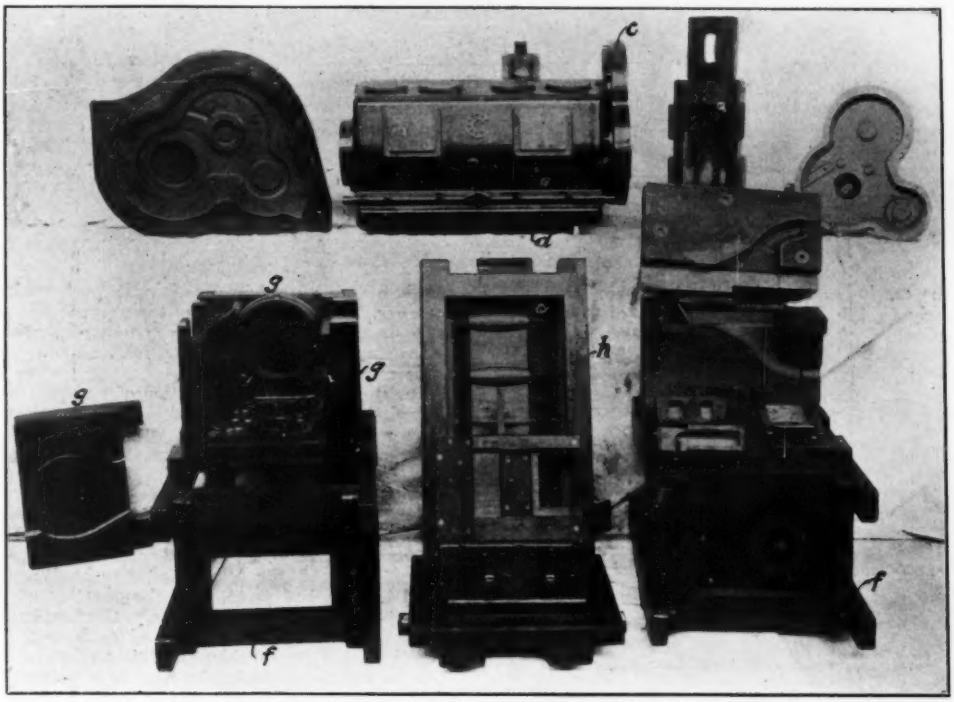


Fig. 2.—Patterns for Ball-bearing Crank Case and Cover.

easy to construct, it being merely a frame with strong battens. The main water-jacket box *o* was all in one piece, *i.e.*, framed and blocks fitted to give the correct internal shape, draught being provided to allow for the extraction of the core. There was a print going the full length of this box, forming a step to allow for the induction pipe *p* and exhaust pipe core *q* to be placed in position.

A gear-box pattern, which was also dealt with, was constructed with metal plate for core print and joint plate, as with the crank-case pattern mentioned, and metal loose pieces and webs were also fitted. The pattern was constructed to allow for the shrinkage of the wood; framed and built up with pieces screwed width way and left with open joints. The core-boxes for this pattern were made in sections and assembled in a frame, as before mentioned. Guides were provided on the core-box to

In regard to the construction of patterns, the first point to consider was the jointing. This point was worthy of more thought than it usually received, for the jointing of a pattern might mean either profit or loss to the foundry, according to the labour in moulding it entailed. Of course, in the absence of a jointed pattern the foundry should have an odd-side made, but it was better, wherever possible, to make the joints in such a position that the smallest amount of work would be given to the moulder.

In concluding his interesting lecture, Mr. Worrall gave some particulars of the system he employed for storing and recording the whereabouts of patterns. He used the card-index system, and by means of suitably-ruled cards, properly filled in as required, it was possible to tell at a moment's notice where any pattern was, where it had been used last, and, if returned, where it was stored.

Fig. 4 herewith shows a six-cylinder crank-case casting, top and bottom halves. There were 5 ft. 8 in. over all, and were within 1/16 in. of the drawing dimensions when cast, this showing that the contraction of aluminium can be arrived at by careful study. Fig. 5 shows the patterns and core boxes

FIG. 3.—PATTERNS FOR WATER-JACKETED TWIN CYLINDER.

for the castings shown in Fig. 4. These were made similarly to the four-cylinder crank case, with the exception of the plates in the pattern, and these can be fitted after the design has been approved.

The photos shown, it might be mentioned, were the work of MR. H. HARLE, an employé of the Company.

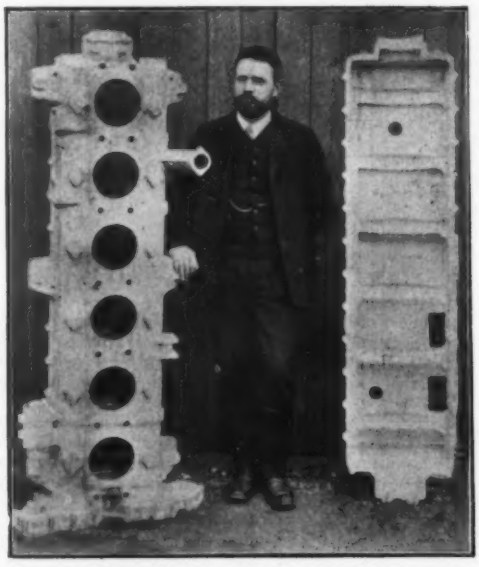

FIG. 4.—TWO HALVES OF FINISHED ALUMINIUM CASTING OF CRANK-CASE.

## Discussion.

The PRESIDENT (Mr. J. W. Horne), in opening the discussion, expressed his keen appreciation of the lecture and of the courtesy of Commercial Cars, Limited, in allowing their patterns to be placed before the meeting for inspection.

MR. J. ELLIS, in supporting an expression of thanks to the lecturer, referred to the sheathing of the top of the patterns with metal. This he considered good practice, as also was the use of guides on the core-boxes, as an aid in drawing. Regarding draught or taper, in some patterns no taper could be allowed, while in others up to $\frac{1}{4}$ in. per foot might be got; so that no rule, as $\frac{1}{8}$ in. per foot, should be laid down as a standard.

MR. COAN, speaking as a user of the patterns exhibited, commended their construction. The only point on which he disagreed with the lecturer was the allowance of draught. He did not consider that the amount quoted was enough, especially on prints, where $\frac{1}{8}$ in. was insufficient.

MR. D. GORDON disapproved of the use of metal as shown on the joint of a pattern. The shrinkage of the wood, he considered, would soon necessitate filing the metal round the joint, and any swelling again would leave a bad joint. On the question of taper, it must be remembered that the pattern-maker often had to keep to the drawing and could not always give the taper he considered advisable.

Some discussion took place at this point on the value of the metal plates on the joint, whereon MR. COAN stated that they had proved very useful in actual practice.

MR. NICHOLSON stated that he had made cylinder patterns and core-boxes similar to those shown, but without the metal plates, and had got 300 castings off without any trouble. The trouble was more with the moulders. As an instance he cited a case where a new foreman moulder condemned as useless a pattern which had given quite good results in the hands of the previous moulder. What was absolutely right with one moulder would be quite wrong with another. He as an apprentice was taught in the North never to make a core where it could possibly be done without; but in the South of England the order was reversed, and cores were used wherever possible. In the North a simple strickle would serve for a mould for which in the South a complete pattern and core-boxes would be made, and the mould would have to be dried. As another instance of the difference in moulding practice, he mentioned a chain case cast in aluminium, which was quite in order when moulded in one shop, but which was not full enough to machine up when made in another foundry. Finally,

it was impossible to get cheaply good patterns for motor-car work; and though they might be expensive in first outlay, they constituted a valuable asset and enabled a founder to deliver a repeat order quickly where another concern could not.

Mr. Bartlett, speaking from the moulder's standpoint, said the latter often could not produce cheaply because the patterns were not good enough. Too much taper on the flange of a pipe would cause leakage, and too much fillet would cause shrinkage and faulty castings. Regarding the differences in moulders, it might also be observed that one pattern-maker did not do the same as another. One would put a print on to help carry a core, while another would not. It was often of great assistance to a moulder if a joint was put on at one end instead of leaving the core to be supported by grains or chaplets. Also it was often of advantage to have a core instead of an elaborate piece of moulding. Regarding the plates on the joint, the expense alone would rule that out in most shops. Even rapping plates were often neglected.

Mr. Slater considered that Mr. Nicholson's remarks very well illustrated the difficulties the moulder as well as the pattern-maker had to meet. The moulder's craft was becoming more and more a skilled calling, for owing to the complexity of the castings and the varieties of shrinkage that had to be met, exceptional discretion was demanded on the part of the moulder.

A Visitor remarked that he could not see the benefit in making these patterns with the metal plates mentioned. In the hands of careless moulders they might buckle and take a permanent "set," and frequently require putting right. (Mr. Worrall here remarked that the patterns shown, although they had seen considerable service, had never required such attention.) It was advisable, continued the visitor, to put the runners on the pattern to ensure correct position. He also considered that the tapering of core prints could be overdone, resulting in difficulty in getting the core into place. Referring to the pattern of the crank case, he observed that the top part had to be bedded; but he would suggest it were better to cut holes, so that the sand could be tucked under, after which the holes could be strickled off.

Mr. Worrall, replying to the discussion, said he considered the trouble with a cylinder pattern was repaid, for with, say, 300 of the cylinders on the road, something was sure to go wrong occasionally, and a new casting be wanted, and then the pattern would come into use again. He had found that cheap patterns frequently did not pay, on account of the increased cost of moulding. He thought it would be difficult to place the runners on the pattern as suggested, for it was practically impossible to know what position the moulder would decide upon, while further, the size of the runners would vary with different moulders. The other points raised, he thought had been threshed out between the different speakers. Regarding the suggestion of holes in the crank case, it would be difficult to strickle the job as suggested, owing to its construction. In conclusion, he strongly advocated meetings of the pattern-maker and moulder, and also the designing staff, to discuss the various points of their work which they had in common.

At the conclusion of the discussion it was proposed and heartily carried that a letter of appreciation be addressed to Messrs. Commercial Cars, Limited, thanking them for allowing their patterns and castings to be exhibited at the meeting.

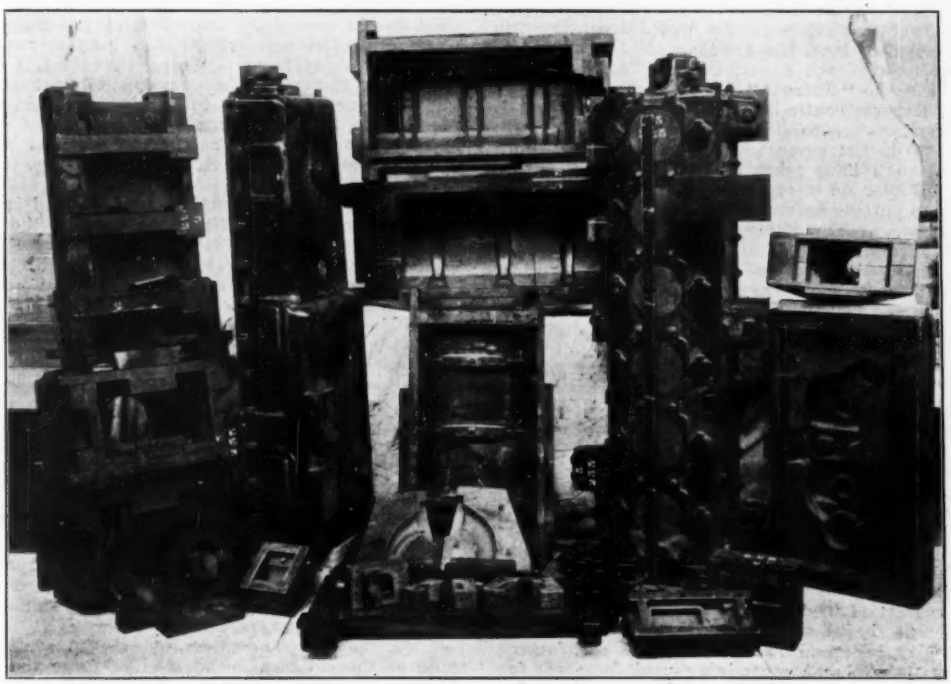

Fig. 5.—Patterns and Core-Boxes for Crank Case shown in Fig. 4.

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Mr. O. L. Remington, manager of Messrs. McLean & Company, machinery importers, of Elizabeth Street, Melbourne, has just arrived in London with a view to securing fresh specialities for introduction to the Australian market. His temporary address is Hotel Cecil, Strand, W.C.

# Cores and Core-Sand Mixtures.

A meeting of the Lancashire Branch of the British Foundrymen's Association was held on February 1, at the Manchester School of Technology. Mr. Penlington presided, and Mr. G. Barnes opened a discussion on "Cores and Core-sand Mixtures."

Mr. Barnes said that in the November issue of the Foundry Trade Journal, last year, there was published a Paper entitled "Cores and Core-sand Mixtures," which most of them had no doubt read. In order, however to make fully intelligible the observations which he was about to give them, it was necessary to have immediately before their minds the contents of the article which he was going to examine and criticise. He would accordingly in the first place read the article.

He then read the Paper, which appears on pages 664-665 of the "Journal" for November, 1912.

Mr. Barnes, continuing, said :—As the subject is an important one to all interested in foundry work, and as I do not agree with all the conclusions of the writer, I have taken advantage of this opportunity of an open meeting to discuss the Paper with a view to putting before you alternative suggestions. The writer of the Paper specifies three mixtures which he makes use of, the first being for heavy work, the second for medium work, and the third for light work. For heavy cores it is recommended to use 60 per cent. of new sand, and 40 per cent. of black sand, with about one bucketful of horse dung to each bucketful of sand.

For medium work the percentage of new sand is reduced, and the percentage of black sand increased as follows, 50 per cent. of new sand and 50 per cent. of black sand, with one bucketful of horse dung to each barrowful of sand as before. For light work, 40 per cent. of new sand is recommended, with 60 per cent. of black sand, and only a small quantity of the horse dung.

Whilst there is, perhaps, no doubt as to the mixtures I have mentioned being quite satisfactory in actual work, yet I have found in my own experience that it is possible to get good results in a much cheaper way. I have made a large number of cores of different shapes and sizes from the mixing which I will give you, and in all cases with satisfactory results. I have seen my mixing used for cores for pillars, valves, piston heads, and on castings for drilling machines with very good results, and I have no hesitation in recommending any foundryman to give this mixture a trial on any small or medium size cores. I take one barrowful of black sand, and to this I add two and a-half pounds of core gum. The sand needs to be milled and riddled, and treated just as ordinary core-sand mixture; there is one good result obtained from using it, and that is that the core does not need blacking, yet it strips away easily from the casting. It cannot be denied that the mixing is cheap and much cheaper than the ordinary method of making core sand; and it has this advantage, that when the castings come to be fettled, the sand falls away if the casting be tapped by a hammer, which in itself is a great advantage over having to use a hammer and bar, as is very often the case. Most of you can bring to mind many cases where it has been difficult to remove the core, and I call to mind more than one case where I have seen men working hard to clear the core out of the boss of a wheel when baring, where they have had to use water to soften the sand. It is my experience that where cores for this kind of work have been made as I have suggested, from black sand and core gum, they come out quite easily, and leave a nice skin to the casting; in fact, the castings made from this sand do not show any signs of being sand-burnt, but always leave a very good and clean face. It will readily be seen what an advantage this is in the case of an intricate core, or one to which it is awkward to get access.

The core gum which I use is very rich in carbon, and it is not an expensive article, as it costs only about 18s. 6d. per cwt., so that about 5d. worth of core gum is quite sufficient for a barrowful of black sand. There are many advantages in using this mixture; for instance, when the cores are dried, they have a face on as smooth as glass, whilst an incidental advantage is that less heat is required than for an ordinary oil core. Of course, I must admit that if the core happens to get burnt in drying, it is not very easy to mend it. Where it is required to rub a core made from this sand, it is necessary to do it with a file or a piece of emery stone, but in my opinion this is an advantage rather than a disadvantage.

The cheapness of the method I recommend is self-evident, because it practically means that the only cost is the cost of the core gum, which, as I have said, runs about 5d. per barrowful of sand. It is simple to use, because it can be added in the powder to the sand itself, or mixed with water and made up into a liquid, which can be added to the sand and mixed amongst it.

The writer of the Paper which I am criticising gives three more mixtures, oil-sand mixtures, which he has adopted as the result of tests and experiments, and whilst I am not prepared to dispute the fact that they may give satisfactory results, I do maintain that the method I suggest is much cheaper. The three methods which he recommends are as follows :—

(1) Fourteen quarts of sea sand, and a full half-pint of linseed oil.

(2) One cwt. of sea sand, and one pint of spermoline

(3) One cwt. of sea sand and three-quarters of a pint of whale oil, or menhaden oil.

If we compare the cost of the sea sand with the value of the old black sand, and compare the cost of the oil with the amount of core gum in my method, it will be seen what a great saving may be effected.

I ought perhaps to have stated at the outset that I am not recommending my sand for loam work, but only for cases where core boxes are used, and in such cases most of you will readily find an opportunity to make a test for yourselves with a very trifling outlay on a few pounds of core gum.

At the close of his address, Mr. Barnes passed round for inspection by the members a number of specimen castings made with cores of various mixtures, black sand and core gum, red sand and core gum and ordinary red sand. He also sketched on a blackboard several cores in illustration of his Paper.

The Chairman said Mr. Barnes had not only criticised the article in the Foundry Trade Journal, but had given them his own views on the subject A great number of points arose in connection with the use of core sands, and a discussion upon them might easily occupy not one, but two or three hours.

Mr. Burling remarked that Mr. Barnes had quoted three mixtures mentioned by the American writer, one of which contained spermoline, and he would like to ask him whether he considered the

core made of the other mixtures was better vented than the core made by a mixture of spermoline or linseed oil and sea sand. Did he think that the results from the latter were better than were obtained from the ordinary core?

Mr. Buchanan: Does he find this mixture of black sand gives a composition which moulds readily in the core boxes? There are usually a lot of little awkward results with this black sand, and I should like to know whether they are not more like oil sand cores in that respect.

Mr. Atkinson asked whether the sand was ground or milled, or merely hand-mixed. Then supposing a core was injured in the foundry, how would it be mended if made of the material suggested by Mr. Barnes? His own experience had been that with intricate cores a little smithy dust mixed with the sand gave excellent results. The mixture mentioned by Mr. Barnes would answer for heavy work, provided the moulders took care to handle the cores carefully. If, on the other hand, the skins were broken, difficulties would ensue. In certain work in connection with a motor car which he had to make, he found that the addition of coke and some smithy dust with the core, he got a far better result than from any of the oil sand or any other mixtures. The black sand and core gum mixed in due proportion, for instance, was better than the ordinary oil-sand. There was no difficulty in getting the cores out; as Mr. Barnes had shown them.

Mr. Barnes, in replying, said he never used oil, which statement he thought answered the question of the first speaker. What he used before was ordinary red sand, black sand, and clay wash; that was before he adopted his present mixture. Neither had he had any information from others who had worked with oil. Continuing, he said it all depended upon whether the sand was too wet or not; if it was very wet it was apt to clog, and when it became dry they would have a job to touch it with the file and to get the skin off. It was, in fact, all a question of the sand. Did he dry his own sand? Yes, he did. Another question put to him was—How do you manage to obtain a skin like the one mentioned? Well, it was not difficult if the core was not burnt; and it was easy to mend up. But once it got burnt, it was practically no good. In one particular core which he had mentioned, he did not think it took ten minutes to get it out. It showed, of course, a want of care if it was burnt. He had had no trouble with the facing of castings. Did he mean to say, he was again asked, that a core such as he had described got burnt in the interval of the handling? That very rarely happened.

Mr. Burling: That is contrary to our experience. It needs a great deal of care.

Mr. Barnes: Of course it does.

A Member asked Mr. Barnes if he had ever left any of the cores on the shelf for a day or two, and with what results.

Mr. Barnes said he had left them until he thought they were just nicely ready for use.

Another Member: How do these cores stand in the mould before they are struck? If you put them in to-day are they ready to be cast to-morrow?

Mr. Simkiss said the subject was one which he should think appealed to every member present. He had something like 60 core makers under his superintendence, and naturally they used large quantities of core sand. He himself was not an advocate of these new-fangled notions and remedies, believing they could get on very well with the ordinary processes. Coke dust was a very simple and useful ingredient; there was plenty of waste coke that was not valuable for the furnace, but it should be used in very small quantities. They used some core gum and some glutrin and meal as binders. Core gum, if used in the proportion recommended to them by Mr. Barnes that afternoon was detrimental, and made it hard to prevent stickiness. The object in using core gum was, he supposed, to save red sand, but then they had to buy the partomel and foundry dust was just as good. In looking through the different mixtures mentioned, he must say he did not think there was much use for them. He had never used red sand alone. The mixture he had used himself consisted of 75 per cent. to 80 per cent. of black sand, and 20 per cent. to 25 per cent. of red sand, all milled, mixed with the meal. With regard to small cores, they could not do better than use new sand, and there were many things which had been patented in the market to avoid the use of red sand. He could call to mind one particular mixture which was said to do away with the use of all red sands. On one occasion he visited one or two foundries in London, and discovered that they were not using red sand, but Scotch sand. If once the iron found its way through the mould and came in contact with these patent mixtures, the job was up. In using 80 per cent. of black sand and 20 per cent. of red sand, they got a splendid face, and the colour inside was equal to the outside. He did not mind adding that he also used that mixture for light work. He did not believe in adding to red sand anything which would form gas, which vegetable matter, for example, would do, for the gas had to be got rid of. If English machine masters had to provide the number of jigs that were used in the United States to carry away the cores, there would be some long faces pulled. Some five or six years ago his firm purchased a core-making machine, but it had never made any cores that they could use. In the first place it was not constructed to make cores that vents could be put in. He had tried all sorts of mixtures to make a core without a vent, but without success. This particular sand, when all was said and done, was right enough in point of cheapness, providing they were engaged on small jobs, but if they had a £20, £30, or £40 job then he should say do not use it. They all knew the effects of bad sand both inside and outside; as to wet sand, he would like to say at once, that anyone using it, whether out or inside, would not obtain good work. He certainly agreed that a very big percentage of the castings in workshops were spoiled from the want of a good mixture of sand, but a greater percentage was spoiled by want of judgment, and not knowing how to use the right sands when available. In one instance in which they had a very big casting to make, they found it extremely difficult to get the small cores to resist the action of the metal.

Mr. W. H. Sherburn, in moving a vote of thanks to Mr. Barnes for his Paper, said he had been listening to find out if any of their friends present knew how to make cores with core gum, without having to hole them up. He felt that a good deal had been held back during the discussion, much more could have been said if the speakers had had the courage or the inclination to say it. Such meetings showed how much the members wanted bringing out.

## British Foundrymen's Association: London Branch.

On Saturday, February 14, the London Branch of the British Foundrymen's Association held the first of a proposed series of smoking concerts, the object of which is to cultivate social intercourse between the members. Mr. J. W. Horne (Branch-President) presided, about 40 members being present, and an excellent evening's entertainment was contributed by the members themselves. The function was thoroughly appreciated and voted a distinct success.

# Industrial Education.

By J. W. Horne, B.Sc., Assoc.Inst.C.E.

At a meeting of the Sheffield and District Branch of the British Foundrymen's Association, on February 18, Mr. James W. Horne, B.Sc., Assoc.Inst.C.E., the President of the London Branch, opened a discussion on "Industrial Education." Mr. Thos. H. Firth, President of the Sheffield Branch, was in the chair, and a very satisfactory attendance included Prof. Ripper, D.Eng. (Head of the Applied Science Department of Sheffield University). Mr. Horne's address was as follows:—

As educational superintendent of pupils and apprentices with Messrs. Fraser & Chalmers, Limited, Erith, the writer for some years had peculiar opportunities of observing the many difficult problems inherent to the institution of a system of industrial education in keeping with advances being made in methods in every conceivable industry throughout the country; and an endeavour will be made to crystallise the discussion of the present meeting and concentrate it on a few of the main points necessary to be considered seriously before any national scheme can be formulated.

In opening a discussion on such a wide subject as that which the term "industrial education" embraces, the importance of which to the nation is recognised by every thinking citizen, it is necessary to divide the subject into the following sections:—

(1) The position of elementary education in relation to the great advances necessarily taking place in the industries of the country, and, in consequence, the need for a higher standard of intelligence.

(2) The industrial education of the rank and file.

(3) The industrial education of the artisan and craftsman.

(4) The industrial education of the foreman.

(5) The training of the manager, the scientific director, and the captain of industry.

It is not possible within the scope of this paper to deal in full with the subject under these five heads, each of which would require a whole book, and would then only be touched on the fringe. They will, however, be briefly surveyed.

## Inefficiency of Elementary Education.

The chaotic condition of elementary education in this country is a prolific subject for discussion and condemnation, not only by authorities on education, but more so by captains of industry and lesser satilites in the industrial world. Personally, the writer believes that enormous strides have been made during the last few years in the standard of education. Though it has progressed by leaps and bounds since the passing of the Act in 1872, its evolution is only in primary stages. It has been more or less retarded by the fact that the citizens have not realised the necessity for the abolition of the County and Urban District Education Authorities, and the constitution of a Central Education Authority who could evolve a flexible but homogenous system applicable to any part of the country. Then again, satisfactory results are not being obtained to-day for the reason that in order to prevent the exploiting of boy labour by many industrial firms, the Board of Education have been compelled to advance perhaps more rapidly than their resources have warranted. In this connection may be mentioned the raising of the age for compulsory school attendance from 12 to 14, which meant an enormous and rapid increase in number of scholars, with the natural result of a dearth of teachers, and, consequent on this latter, loss of efficiency and lowering of the average standard of teacher. This has been rectified during the last five years, and there is no possible doubt that it has resulted in a great rise in the standard of intelligence of the boys leaving school. As a natural result of the increase of the age to 14 years, and dearth of teachers, the size of the classes became unwieldy. It is not possible for one teacher to do justice to 80 pupils. This again is being gradually rectified, and when the classes are reduced to 40 pupils it will be time for industries to grumble if there is lack of intelligence in the product coming from the elementary schools.

Again, it occurs to the writer that if there is a diminution in the standard of intelligence sent out from the elementary school, the teachers cannot be blamed for the whole of it. Even to-day, the most valuable side of a boy's education is that which he should obtain at home. Any careful inquirer will find that owing to a variety of causes home education is a dwindling quantity, the main cause probably being the introduction of free education producing irresponsibility in the parents.

The solution of the problem is the raising of the numbers and status of the profession, the reduction of numbers of pupils per teacher and the realisation by parents that they too have an enormous part to play in the production of intelligent citizens. The writer does not wish to labour this side of the subject, but there is one other subject that must be touched upon. Industries ask invariably the question: "What use is it to have the boys taught subjects which are of no value to us or our works?" The whole function of education, and especially elementary education, is to carefully watch and nurture the mind of the child, develop his intelligence, and with these necessary adjuncts to make a man and an honourable citizen, not a money getter.

This is better expressed by Mr. E. G. A. Holmes, (retired Chief Inspector of Schools under the Board of Education), who says:—"The function of education is to foster growth, to give to the child nutritious food and opportunities for the exercise of his faculties: when the parents and teachers have provided these they may stand aside and let the child do the rest."

Under this heading have been introduced in as few words as possible a few thoughts which are worthy of elaboration in the discussion. Personally the writer sees no reason to deplore the position of present-day elementary education: it is a healthy child, and bound to advance rapidly.

## Industrial Education of the Rank and File.

The Board of Education some three years ago issued a White Book compiled by a consultative committee appointed in 1907 to consider the subject of compulsory attendance of adolescents at continuation classes up to the age of seventeen. To crystallise discussion on this part of the subject, the writer will quote the recommendation made by this committee, in order to obtain employers co-operation.

*Employers' Co-operation.*

(1) Systematic visitation of parents whose children are about to leave the elementary day schools, and of

employers, with a view to securing their co-operation in the further education of the younger members of the community. The officers in charge of this work to be very carefully selected.

(2) The organisation of advisory committees of representative employers and workers in each trade, and the investigation of the industrial and other conditions of the district, with a view to the provision of evening and other classes in close adjustment to the economic and social needs of the population, and to the improvement of the attendance at such instruction.

As regards employers, their most effective method of improving attendance at continuation schools is to make such attendance a condition of employment.

Where such a plan is impracticable employers might:

(1) Exempt workers who are attending continuation schools from working overtime, or allow them to leave early on class days or come to work late on the following day;

(2) Refund the fees, partly or wholly, of employés who make regular attendance at continuation schools;

(3) Give prizes, scholarships, special opportunities for promotion, or extra wages to employés regular in their attendance at continuation schools;

(4) Give extra wages to apprentices for good marks which depend partly on regular attendance at continuation classes, partly on good conduct there, and partly on examination results;

(5) Assist local education authorities by advice as to the instruction given in the continuation schools;

(6) Contribute to the funds of special classes.

All employers, the committee suggest, should be placed under statutory obligation to enable workers of both sexes under the age of 17 to attend continuation classes for such periods of time and at such hours as may be prescribed by by-law adopted by the local education authority with the approval of the Board of Education. Further, employers are to supply to the local education authority on demand the names of all such persons.

In order to bring these recommendations into force as soon as possible without compulsion, the Labour Exchanges already instituted were utilised and Juvenile Advisory Committees were appointed on the lines of the recommendations. The writer has acted on the Woolwich Juvenile Advisory Committee, and can vouch for its utility.

These recommendations, however, do not go far enough. Industry to-day lives in strenuous times, and there has been on enormous speeding up, so that, the writer holds, a youth between the ages of 14 to 17, after doing his 54 hours manual work is physically unfit to devote the time expected of him for mental and intellectual development. The old half-time system has been condemned by an Inter-Departmental Committee, and the half-timer has to go. The Board of Education have here lost a splendid opportunity of evolving from the old half-time system a new part-time system to meet the recommendations on compulsory continuation classes from 14 to 17, by which the greater part of the education would take place during hours when the child is physically fit. The industries of the country would derive the benefit of better physical conditions and intelligence, so it is for the captains of industries to put their heads together and lead the way.

Perhaps it will be well to expand here the writer's idea of what constitutes the essential of efficient continuation education. It is a recognised fact that the boy of 14 years of age leaves school at the point when his brain is reaching the receptive stage: up to this point he has been taught to imbibe knowledge in the form of facts, without to any extent using his reasoning faculties; and continuation classes dealing with the boy in this receptive conditon should be so organised that whatever subjects be taught, they should lead him to the development of his reasoning power rather than the amassing of facts which may, or may not, be useful to him in his occupation. To develop the thinking powers and intelligence of a youth between the ages of 14 and 17 is of more value than amassing knowledge. A custom prevalent to-day in the evening classes of most technical schools is to hustle and cram facts into the brains of the pupils; but a lad in any industry should not begin this phase of his education before he reaches the age of 17, and the mere monetary value at this stage either to himself or his employer should be a mere detail.

### Industrial Education of the Artisan.

The next question is what should be evolved to replace the apprenticeship system. Those who are interested in the decay of the old apprenticeship system in this country would do well to peruse a book on the subject by Reginald A. Bray, Chairman of the Juvenile Advisory Committee, London, in which the author propounds a system to take the place of the old apprentice system under conditions existing to-day.

Given the premise to be correct that a national system of apprenticeship to produce efficient artizans and craftsmen is necessary in order that we may enter into industrial competition on equal terms with other countries, then the captains of industry must of necessity come forward and work the scheme. From experience the writer ventures to put forward a few suggestions which might be incorporated in such a scheme. As a basis is taken the fact that owing to the rapid advances being made in technical science, a higher standard of intelligence and knowledge among artisans and craftsmen is as essential as efficiency in mechanical operations. From this it follows that apprentices, if they are to become useful soon after entering on apprenticeship, must enter better equipped from a technical standpoint. The following suggestions are therefore put forward with confidence:—

(1). That the age for starting in apprenticeship should be 17, and that necessarily the rate of pay should be raised.

(2). That these apprentices should be drawn from a secondary school or trades school. In the latter case the lads would be specially selected from the elementary schools at 14 or 15 years, and assisted by means of scholarships and maintenance allowances.

(3). The term of apprenticeship should be three years, and wages be raised according to earning capacity.

(4). Experience in other departments to be granted for merit.

Apprentices produced by such a system would have such a groundwork of general and technical education as would enable them to benefit from evening classes, though, if possible, time should be allowed for this work, and classes held specially in the works. Many firms have systems dealing with the education of their apprentices, and valuable inducements are offered and taken advantage of; but the extreme strenuousness of the life during the growing age is a source of great danger to the future physical and metal condition of the artizan class, as these systems are now worked. Mention may be made of the scheme operated by Messrs. David Brown & Sons (Huddersfield), Limited, which offers facilities for apprentices over sixteen years of age attending evening classes:—

(1) All apprentices are expected to attend evening classes and to follow courses approved by the evening school officials.

(2) Examinations will be conducted by the evening schools at the end of each session, and also a special examination to ascertain the progress made by each apprentice at his own particular trade or employment will

be conducted by a committee of the works' staff appointed by the management. The questions set at this examination will deal with subjects such as the following:—The care and working of different classes of machinery, the use of verniers, micrometers, and other instruments and tools, and methods of machining or erecting different classes of work.

(3) All apprentices making an average attendance at classes of 90 per cent. or over will be allowed half their school fees.

(4) A record will be kept by the firm of the conduct of every apprentice both at the works and at the classes, each one being allowed a certain number of marks as follows:—

Homework and general conduct at classes, 100.
School examination, 100.
Works examination, 100.
Timekeeping at works, 100.
General conduct and efficiency at trade or employment, 100.

(5) Prizes will be offered at the end of the session to the apprentices obtaining the highest number of marks:—

First prize, value 20s., for those employed in the works.
Second prize, value 15s., for those employed in the works.
Third prize, value 10s., for those employed in the works.
One prize, value 15s., for those employed in the drawing-office.
One prize, value 15s., for those employed in other offices.

These will be given in the form of tools, books, or instruments, according to the choice of the winners.

In addition to prizes the following advantages will be offered:—

(6) Apprentices making 80 per cent. of the total marks will be offered six months' training in some department of the works—to be decided upon by the management—in which they have not previously been employed, and will receive an advance in wages of 1s. per week for the succeeding year.

(7) All prize-winners will be allowed the full amount of their class fees for the year succeeding that in which the prize is won.

NOTE.—The facilities, with the exception of (6), will be extended to youths under twenty-one years of age employed as machine operators and those employed in the offices.

### The Industrial Education of Foremen.

The first point under this heading is that the term "foreman" is out of date; the substitute should be "shop-manager." The value of a change of name will be well appreciated; we want an improvement in the status of the member of the staff who is responsible for the running of everything connected with his shop. Foremen of the best type should be easily obtained from a system of apprenticeship as sketched above. In order that a shop be run efficiently, a shop manager must have a thorough knowledge of men, and a broad outlook. It is also essential that his technical knowledge be sound, in order that he may keep up with current developments in methods. The writer would suggest, then, that boys should be selected from the apprentices trained by the foregoing system, and be sent to college for two years.

At this point the speaker referred to the training of foremen at the works of Ludwig Löwe & Company, Berlin.

The system is briefly as follows:—

Two winter courses, consisting of one preliminary and one advanced, of 100 hours each. Thirty men are admitted each year. The first course lays stress on the workshop and gives instruction in calculation, and the fundamental laws of physics and mechanics. Here instruction is given in cutting speeds, gear systems, capacity of machines, production of raw materials, pig-iron, steel, etc., while sketching for machine parts and fixtures is also part of the training. The second course covers theoretical and practical calculation of work and the figuring of cost of manipulation, a survey of labour Laws, legal rules of notice and discharge, wages payment, employment of juveniles, safety provisions, and many other matters. The management of the course is in the hands of the superintendent of the apprentices and the apprentice school. Besides the foregoing, instruction is imparted by leading officials of the works in various departments, each in his own speciality; and even the general manager imparts his experience to the workmen in this manner.

It should be evident, without further resmark, that such arrangements are those for this foremen's course, if rightly carried out, can be of the greatest benefit to the factory, even if for no other purpose than to discover the actually capable men.

Owing to lack of time the subject, the Training of Managers and Captains of Industry was not treated.

### Discussion.

MR. T. H. FIRTH, in opening the discussion, said he had been greatly interested in Mr. Horne's address. It was a good idea that apprentices should come at 9 o'clock in the morning and have afternoons off to attend technical classes; but in many works it would take a bit of working out. Some firms could make profits with machines standing idle for so many hours; but many others found it none too easy to make their concerns pay However, there was no doubt that one way to ensure success was to have good men, and especially good foremen.

PROFESSOR RIPPER said the lecturer had covered a tremendous field, and one had views on almost everything that had been touched upon, but he would like to take one or two of the salient points. There could be no question whatever but that in the ever-increasing demands being made upon industries and trades for ever-increasing quality, the works must be supplied with competent people. The British market to-day was a world-market and competitors were keen, well-educated and well-trained, in countries like Germany and America, and while we might have our own more or less traditional ideas about education and the training of pupils, when they were up against the problem that English manufacturers found themselves faced with in the world-markets—competing with people who were trained up to the hilt—then we were bound to see if we could not improve the present conditions; for he was sure that no Englishman would say that present conditions were entirely satisfactory. For many years a few great firms in this country had given much attention to the training of apprentices. Probably the earliest to do it were the Admiralty at the various dockyards. Here there was a splendid system of training apprentices, amounting very much to that which the lecturer had outlined, *i.e.*, they gave the apprentices two afternoons a week off from the works, for which they were paid. In addition to that the apprentices were required to attend classes on something like three evenings a week. At the end of their apprenticeship the best of them were selected and sent up to what used to be Greenwich, and afterwards became the Royal School of Mines, for a special course of training there for three years, and at the end of that time the Government found them important positions in the various works throughout the country. By that system of training apprentices the Government had managed to produce a wonderfully expert and capable set of people. Some of the leaders in the great marine engineering and shipbuilding industries were men who came through that training. Perhaps the most

distinguished name he could mention—Sir William White—was himself a workman-apprentice in a dockyard, and who through the facilities offered by the Government was able to rise to the great position to which he had attained. There were men well-known in Sheffield who were also trained in the same way. The late Sir Francis Elgar, chairman of Cammell & Company, passed through exactly the same mill. Other firms throughout the country had been doing something on the same lines. As doubtless they knew, the pupils of Messrs. Vickers, Limited, went to the Technical Department of the Sheffield University for six months in the year—the winter session—and spent the summer in the works. They did that for three years in succession, and at the end of that time, if they were successful students, they had a certificate indicating the course of training they had had.

In facing this problem, continued Dr. Ripper, it should be borne in mind that they were compelled to attend to it, whether they wanted to or not. The lecturer had mentioned the German firm of Ludwig, Löwe & Company. He had been there and seen what they were doing, and could therefore fully substantiate all that Mr. Horne had said. Quite recently the foreman in charge of the education of the apprentices at that firm came to see him and asked if he could see what was being done at the University. He (Professor Ripper) showed him through the place, and afterwards took him to lunch, and throughout the time that man—a foreman in a German machine shop—was talking about the great literature of the English language; he was discussing the wonders and the beauties of English literature, and doing so in perfect English. He knew as much about Tennyson, Burns and Shakespeare and other great writers as any thoroughly well-educated man in this country. That man was a machine foreman, and that was the kind of man that was setting the tone and the standard of intelligence among the young people of their competitors. Though in America attention to training was not so general as in Germany, there was still a remarkable public spirit in America, which showed itself in this way. There were great institutions throughout the whole of the States, and these institutions undertook the training of young men for the various industries and professions; they took them only between the ages of 18 and 22, and insisted on a four years' course. The usual course in this country was a course for three years, commencing at 16, and any proposal to commence at 18 and going on for four years would be looked upon as somewhat doubtful. But in America, although the course commenced at 18 and lasted four years, these colleges were crowded with students. Instead of the hundred or two found in an English technical school, there would be found from 2,000 to 4,000 students in these great State colleges of America, being trained for various positions, very largely in the industrial world, although covering other professions as well.

Old-fashioned notions about what was possible, the speaker continued, would certainly have to be seriously revised. The British people were not necessarily behind other nations; as a matter of fact, their output was greater than that of other countries, their imports and exports to-day were greater, and therefore as world-market competitors they were still at the top of the tree, notwithstanding all this apparent, and, he was afraid, real advantage which these other nations had. But the future was ahead; it was not what had been done up to the present that was in question, but their power to hold their own in the future against their competitors. The power of British manufacturers to hold their own depended upon the way in which they were trained. They could no more expect to hold their own in industry unless they were trained than they would in athletics. The great question of what was a suitable training was a very large and important one, but if they did not train in industry and in science they could not hope to win in a competition which depended so much upon intelligence and skill and brains. He did not think, however, that the workshops of this country were by any means unimportant as a means of instruction; he thought they were excellent types of technical schools in themselves and because one young man spent so many years in a technical college while another had been in the shops, there was not necessarily a certain indisputable measure of excellence on the part of the one over the other. While no man could refuse to believe in the enormous advantages of a thorough education, he felt that at least half the battle was the individual inherent quality of the person himself. It was the material which was available to train which was the secret of the whole thing, and he believed that the reason why to-day England held its own was in the inherent qualities of its people. But he did feel that if added to the inherent qualities of their people they enjoyed the advantages of training which their competitors had, then there would be no fear whatever but that they would always be able to hold their own in the markets of the world. (Applause.)

*(Discussion to be continued in our next issue.)*

## Correspondence.

### British Foundrymen's Association.

*To the Editor of the* FOUNDRY TRADE JOURNAL.

SIR,—As one of the nine who met together at the Cobden Hotel, Birmingham, to discuss the advisability or otherwise of forming an association of foundrymen, it comes as a surprise to learn, in the words of Mr. F. Penlington, that "the Foundrymen's Association was initiated in Manchester, and that the Lancashire Branch had done much of the pioneer work of the organisation."

At this moment it might be interesting to recall that on page 125 of Vol. 5 (1904) of the FOUNDRY TRADE JOURNAL, the first meeting was reported in the following words:—"A meeting in connection with the above was held at the Cobden Hotel, Birmingham, on Saturday, April 9, 1904, when a circular was drawn up for issue to interested persons. The following officers were appointed:—President, Mr. Robert Buchanan, Birmingham; Secretary and Treasurer, Mr. Wm. Finch, Gloucester. Committee, C. Morehead, Rugby; J. Ellis, Woolston, Hants; F. W. Shaw, Birmingham; John G. Stewart, Urmston, Lancs.; F. J. Cook, Birmingham; Percy Longmuir, Sheffield; William Vickers, Birmingham."

Judged by this list, Manchester does not seem to have played a very important part in the initiation. As to the Lancashire Branch, it is hardly likely that a child could give birth to a parent.

As a matter of fact, it was the energy displayed by the FOUNDRY TRADE JOURNAL and by Mr. F. W. Finch in his correspondence to that journal which were mainly responsible for the initiation of our now wonderful organisation, the B. F. A. and its Branches.

Yours, etc.,
FRANCIS W. SHAW.

1, Lancaster Avenue,
Didsbury, Manchester.

## Moulding of a Cast-Iron Box Beam.

By A. Martin.

The beam shown in Fig. 1 is of the box shape, and open only at each end. It is 15 ft. long, and 12 in. square, having a core running right through, 10½ in. square, with the necessary facings for the different bolt holes in the casting. It was usual to make this core in lengths of 3 ft. 6 in., placing chaplets in the bottom of the mould for the cores to rest on, and chaplets in the top to stop the cores from lifting to the face of the mould.,

In this case there was an order for a large number of the beams, and the method adopted was to make the core all in one piece, 17 ft. long, allowing 1 ft. at each end to fit into the prints.

In the making of the core box two planks 2½ in. thick were used as sides, with two end pieces, one screwed to each side at the proper length. Four bolts were used to hold the core box secure, one at each end, and the other two divided out to come just above the core iron.

The core iron, as shown, was made 16 ft. 10 in. long, 4 in. wide, and 6½ in. deep, with prongs on each side at the bottom, projecting out 2½ in. and 1½ in. wide, and ½ in. wide at top, with a space of 3 in. between each prong. Two wrought-iron staples were cast in the core iron 4 ft. from each end.

The method of making the core was to make it on the same bed that the casting was made on, the straight edges at each end of bed being iron ones and left in until the job was finished. A black-sand bed was made, taking care that it was hard, and the two sides of core box were placed on and fastened together with the bolts at each end. Plenty of parting sand was thrown on the bed, which now formed the bottom of core box, and one inch of core sand was put all over the bottom, tightening with the fingers. The iron was clay-washed, and the core sand already put in sprinkled with clay wash. The iron was dropped in, bumping with a heavy bar or hammer to thoroughly bed it, and when bedded the two stay bolts were placed through the sides and screwed up to stop ramming the core box out. Ramming up was continued to within one inch of top of the core iron with core sand, and then lined up for fine ashes, sprinkled with clay wash and vented with vent wire up the sides of the iron; then filled in with fine ashes 1 in. thick, above and on top of the core iron. Next the top of the ashes was clay washed, and rammed up with core sand, and a small wire was used to vent to the ashes before strickling off. The bolts were left in the core box, and the staples in core iron were hooked to in order to lift the core and core box together with the crane. Underneath was staked level with the bottom of the core box, and smoothed with the trowel. The core was then placed on the bed again, the core box taken away, and the core finished and blacked, when it was picked up again and blacked underneath. Two plates 2 ft. long were placed on the stove carriage, dry sand put on, and the core dropped on.

The black sand was taken out of the bed a little wider than the pattern, and a facing-sand bed made, venting it to the cinder bed underneath. When the block pattern was placed on the bed two bearing irons were placed under the prints, one at each end, about 4 in. wide, 1 in. thick, and 2 ft. long, and rammed up in the usual way, when the pattern was drawn out of the sand and the mould finished: the core was dropped in, each end resting on the bearing irons in the prints, and the prints made up on top of core. When the top part was placed on the core was packed at each end, iron and iron from top of core-iron to the moulding box, and weighted or bolted down to a bolting foundation. This method does away with chaplets, and short cores, which do not always fit correctly, while the same iron can be used for any number of cores.

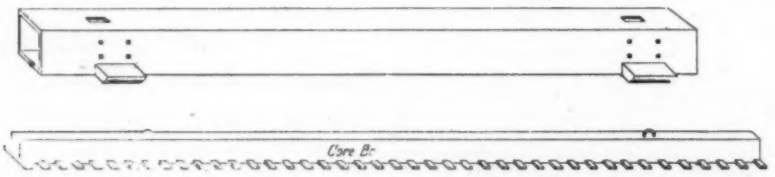



Fig. 1.

## A Foundry Trades Exhibition.

In June next will be held at the Royal Agricultural Hall, Islington, the first Foundry Trades Exhibition in the United Kingdom. While it is true that exhibitions have been held in which foundrymen are necessarily interested, this is the first occasion on which foundry trades requisites form the predominant feature of an exhibition, and it is somewhat surprising that this is so, considering the great importance of the foundry trade with regard to general engineering. A properly equipped foundry is an absolute necessity in every up-to-date establishment, and this Exhibition, coming at the time of the Annual Convention of the British Foundrymen's Association, will be a most welcome addition to the attractions of London. We understand that the Council of the Association have accepted the invitation of the Management of the Exhibition to pay an official visit of inspection.

Judging by the syllabus of proposed exhibits this undertaking will be extremely interesting to all who are connected with the various branches of the foundry trades. Also, since the second Chemical Industry and Engineering Exhibition will be held concurrently with the Foundry Trades Exhibition in the same building, visitors have the privilege of attending both exhibitions at the one charge for admission. The fact that the undertaking is in the hands of the two gentlemen who organised the recent Engineering Exhibition at Olympia with such conspicuous success is sufficient to indicate that the matter is under efficient management.

It is proposed to arrange a series of lectures and papers at the Exhibition on scientific and other subjects of general interest to the foundry trades. We understand that a considerable number of important firms have already secured space for the display of exhibits.

## An Oil-Fired Melting Furnace.

From time to time reports have appeared with regard to the successes that have been achieved by liquid fuel in comparison with solid fuels, although this system of firing is only in its infancy. It will, therefore, be interesting to our readers to give the following notes regarding the "Buess" oil-fired crucible furnace. This furnace was briefly described in the Presidential address by Mr. H. L. Reason, before the Birmingham Branch of the British Foundrymen's Association (see our issue of December, 1912). The advantages claimed for it may be briefly summarised as follows:—Saving in fuel; easy and simple handling; less liability to accidents; avoidance of deterioration of the metal through sulphur and slag; absence of refuse, as ashes and soot, and of the obnoxious smoke fumes, etc.;

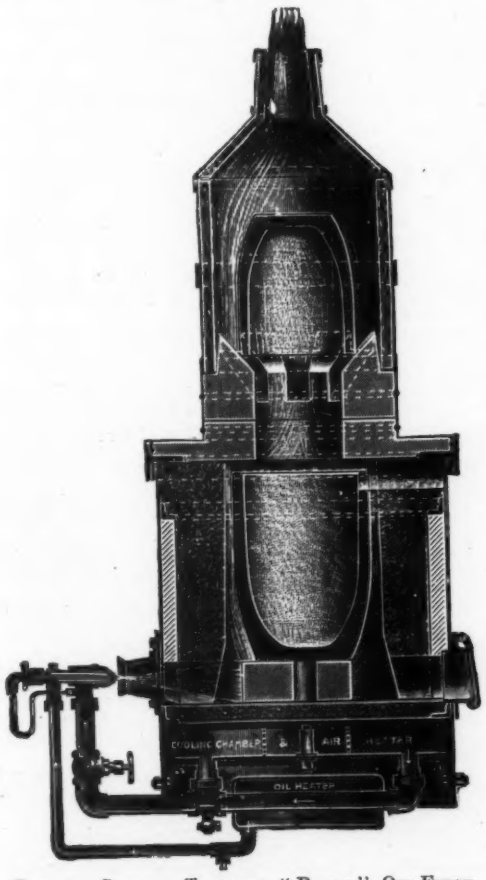



FIG. 1.—SECTION THROUGH "BUESS" OIL-FIRED CRUCIBLE FURNACE.

longer life of crucibles and linings; and considerable saving in time and wages. Naturally the difference in the type of fuel requires modification of the usual construction of a solid fuel furnace, and the "Buess" furnace, it is claimed, has proved successful in practice.

During the melting process the pre-heater remains on the furnace, and in addition to warming the charge when melting scrap and heating the pouring crucibles, serves to retain the heat in the furnace so that the flames do not escape too readily, and prevents dirt from entering the charge. It is raised and lowered by the crank shown and is swung on one side whilst the furnace is being poured or charged. If a crucible is used for pouring the metal, this can be heated by placing it in the position shown in Fig. 1 about 10 minutes before the metal is ready, so that it is not necessary to employ a separate heating apparatus for this purpose.

The furnace is supported on trunnions, through which run the pipes carrying the oil and air supply, and is tilted for pouring purposes by a worm wheel and gearing. In Fig. 1 is shown a section through the furnace and burner. A distinguishing feature is the method employed for cooling the bottom of the furnace and heating the blast. Compressed air is used at from 7½ to 10 lbs. pressure, which after passing through one of the trunnions enters the base of the furnace, raises its own temperature to between 390—480 deg. Fahr., by blowing against and absorbing heat from the bottom, thus keeping this part cool and preventing the formation of slag, which considerably increases the durability of this part of the fire-proof lining. It is then conducted through a small reservoir under the bottom of the furnace in which the oil is circulating, warms this, and then reaches the burner. The warming of the oil enables thick, crude oils to be employed and prevents clogging of the burner. Combustion is perfect, as is indicated by the dazzling white flame and absence of smoke. The crucible stands on a specially-shaped fireclay brick which ensures the flame being evenly distributed all round it.

The starting of the furnace is exceedingly simple, as all that is required is to place a piece of burning waste or paper inside the furnace, and then open a little the two valves of the burner; the starting is then the work of a few seconds It is advisable to increase the heat slowly until the crucible is red-hot, otherwise breakages are likely to occur. The proper admixture of air and oil is controlled by the valves, and they should be arranged so that a pure white smokeless flame is seen issuing from the top of the pre-heater. The burner is so arranged that a reducing atmosphere can be obtained at any time, and a scale is fixed behind the burner head, so that when metals of low melting point, as aluminium, zinc, lead and tin, are in the furnace, the quantity of air passing through the burner can be regulated in order to change the heating power and time of melting.

Should a crucible break during melting, the furnace is slightly tilted and the metal run out of the slag hole into a ladle, crucible, or other suitable receptacle. As the slag hole is placed directly opposite the burner, and the furnace can be tilted while the burner is working, the metal is recovered whilst fluid, and in the shortest possible time.

The cleaning of the burner and oil pipes is done by a very ingenious contrivance. The nose of the burner consists of a rose, to assist in atomising the oil, and by exchanging this for a cap and then opening the air and oil valves, the compressed air being unable to escape from the burner enters the oil pipe and pushing all obstructions before it cleans the pipe right through to the oil tank. We may mention here that sometimes stoppages occur with oil furnaces in cold weather, owing to the oil solidifying into small globules, which are frequently taken for dirt. Stoppages of this description are impossible with the "Buess" furnace owing to the arrangements made for heating the oil, before-mentioned.

In hot weather, or when using oils having a low vapourising point, the compressed air, instead of being heated first, and then warming the oil, is passed through the oil reservoir to cool the oil, and then into the base of the furnace. In this way, by the mere turning of a lever there is at disposal an

arrangement by which the oil can be either heated or cooled just as required.

A special feature of the "Buess" furnace is that it is always ready for use, and is free from danger. It is capable of producing first-class work with small loss, low cost of repairs, and the crucible has a long life. In one installation the output of a 4-cwt. furnace was 8 charges in 10 hours, the crucible lasting for 60 charges, and the lining remaining intact after 969 charges. The oil consumption has only been 8 per cent. of the weight of metal melted. In conclusion, we would mention that the furnace is not only suitable for melting all non-ferrous metals, but also iron and steel, and has been particularly successful in malleable-iron foundries. It can be installed in any foundry without special arrangements being necessary.

## The Junior Institution of Engineers.

In the January monthly volume of proceedings of the Junior Institution of Engineers, an interesting, though brief, survey of the work of this Institution is given by Mr. Reginald Krall, who states, in the course of his remarks, that there is probably no other Institution in existence having a membership of over one thousand which, whilst specially devoted to the interests of the young engineer, at the same time enlists not only the sympathy, but also the active support of senior engineers. Another feature is the Friday evening chats, particularly initiated for the benefit of the junior member. For his benefit also, the Durham Bursary was provided, this being tenable only by a member under the age of 23. On the other hand the Canet Medal is awarded only to one of the most eminent men in the profession. Engineers of the highest professional standing have visited and spoken at the meetings, at which junior members nevertheless are also always heard with attention and encouragement. They are, moreover, a cosmopolitan body, with members all over the world, and papers and contributions on every engineering subject are welcome. The social functions are many and various, attended by all classes of members and friends (including ladies), and are essentially friendly gatherings devoid of stiffness and formality. The visits to works are always well chosen and well attended, being arranged with special regard to the convenience and pocket of the junior member.

Mention may also be made of the Institution's Benevolent Fund and of its library, which is becoming well stocked with the best class of technical literature. Employment is found for members where possible, and greater facilities are likely to be afforded in this matter in the near future. The Journal, issued monthly, is probably published more promptly than the proceedings of any other well-known engineering society. The plan which has been adopted of including in it papers in advance of their being read will probably enhance their value by raising the already high standard of the ensuing discussion.

The fundamental reason of the success achieved and so long maintained, the writer considers to be "*camaraderie*" and "*esprit de corps.*"

The Institution, originally formed by young engineers expressly for young engineers, has found a much wider field of effort and enlisted the interest of a much larger section of society, although always foremost in its policy has remained the advancement of the young engineer. It is this policy which has secured so remarkable a list of presidents, vice-presidents, honorary members, and honorary lecturers. Their support would, however, have been lacking were it not that they are doing work of value not only to their own members but to the engineering world in general.

As regards the membership, it is pointed out that there is also an Associate Class, which comprises two entirely different classes of men:—(1) Those young engineers still perhaps in their pupilage, who, owing to their short experience, are not yet qualified for full membership. (2) The much older man who has never been fully trained or occupied as an engineer, but is interested in some way or other in engineering. The Institution is thus in a position to welcome a class of men of ripe experience and considerable influence in engineering circles who could not be other than a power for good to the Institution and its works.

## New Companies.

ARCUS & COMPANY, LIMITED.—Capital £2,000 in £1 shares, to carry on the business of engineers.

GARVIE & COMPANY, LIMITED.—Capital £500 in £1 shares, to carry on the business of engineers.

WILLIAM JAMES, LIMITED.—Capital £6,000 in £1 shares, to carry on the business of engineers, etc.

SIEDLES PATENTS, LIMITED.—Capital £1,000 in £1 shares, to carry on the business of ironfounders, etc.

MALCAST FOUNDRY, LIMITED.—Capital £5,000 in £1 shares. Registered office: Crescent Works, Pleck Road, Walsall.

ALLEN BARTON & COMPANY, LIMITED.—Capital £3,000 in £1 shares, to carry on the business of iron and brass founders.

HAGGAS, LIMITED.—Capital £3,000 in £1 shares, to carry on the business of engineers, etc. Registered office: Grace Street, Leeds.

CONISTON ELECTROLYTIC COPPER WORKS, LIMITED.—Capital £6,000 in £1 shares. Registered office: 4a, Cockspur Street, S.W.

THOS. BOSWELL & COMPANY, LIMITED.—Capital £3,000 in £1 shares, to carry on the business of file and steel manufacturers, etc.

WILLIAM DENTON, LIMITED.—Capital £4,000 in £1 shares, to carry on the business of engineers. Registered office: 2-3, Eldon Street, London, E.C.

LOUIS WEARDEN & GUYLEE, LIMITED.—Capital £1,500 in £1 shares (400 6 per cent. cumulative preference), to carry on the business of engineers, etc.

ALMA MANUFACTURING COMPANY, LIMITED.—Capital £8,000 in £1 shares (1,500 six per cent. cumulative preference), to carry on the business of engineers.

HADFIELDS, LIMITED.—Capital £1,000 in £1 shares, to carry on the business of manufacturers of steel castings, etc. Registered office: Hecla Works, Sheffield.

JAMES BUCHANAN & SON (LIVERPOOL), LIMITED.—Capital £100,000 in £1 shares, to carry on the business of engineers, etc., and to acquire the existing business.

P. L. WILCOX, LIMITED.—Capital £5,000 in £1 shares, to carry on the business of brassfounders, etc. Registered office: 19, Church Street, Camberwell, S.E.

JEREMIAH MARSDEN & COMPANY, LIMITED.—Capital £5,000 in £1 shares (2,000 5 per cent. cumulative preference), to carry on the business of ironfounders, etc.

GEORGE MERCER & SONS, LIMITED.—Capital £2,000 in £5 shares, to carry on the business of engineering contractors, etc. Registered office: Pembrey Road, Llanelly.

LAMBOURNE, WOOLLARD & COMPANY, LIMITED.—Capital £1,000 in £1 shares, to carry on the business of ironfounders. Registered office: 3, New Street, Birmingham.

DONNELLY, MACLEOD & COMPANY, LIMITED.—Capital £5,000 in £1 shares, to carry on the business of engineers, etc. Registered office: 49a, Wilson Street, Finsbury, E.C.

JOSEPH RATCLIFF & SONS, LIMITED.—Capital £15,000 in £1 shares (5,000 preference), to carry on the business of brassfounders, etc. Registered office: 47, Pritchett Street, Birmingham.

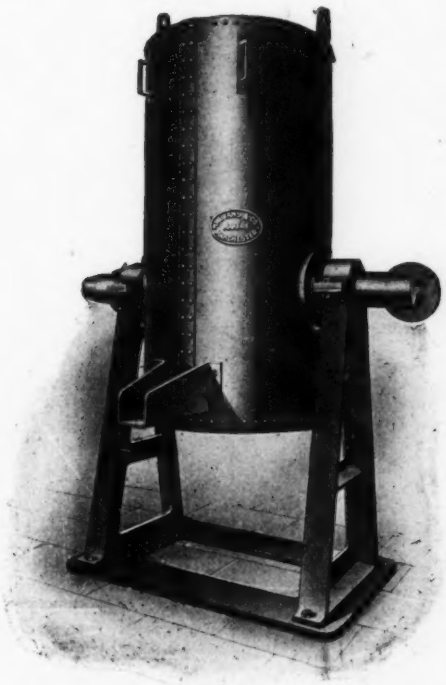
INDIAN FOUNDRY LIMITED.—Capital £5,000 in £1 shares, to carry on in India and elsewhere the business of manufacturers of and dealers in hollow-ware, iron founders, engineers, etc. Registered office: Albion Works, Albion, West Bromwich.

AS SUPPLIED TO THE ADMIRALTY, WAR OFFICE,
COLONIES, AND FOREIGN GOVERNMENTS.

# THE Cupola.
# Evans's Rapid.

**Foundries Completely Furnished.**

## EVANS'S NEW CUPOLETTE
## For Emergency Work.



**James Evans & Co.,**
**Britannia Works,**
***Blackfriars,***
***MANCHESTER.***

**Telegrams: "LADLES, MANCHESTER."**

## Trade Talk.

LAMBERTS, LIMITED, have removed to 55, Southwark Street, London, S.E.

THE DAVIS GAS STOVE COMPANY, LIMITED, are extending their works at Luton.

LAND has been taken at Trafford Park, Manchester, for new works for the Carborundum Company, Limited.

MR. J. C. BARNS, metal founder, of Hill Street, Southwark, London, S.E., has been adjudged bankrupt.

MR. W. C. BARKER, aluminium and brassfounder, of Gun Lane, Strood, Rochester, is considerably extending his foundry.

MESSRS. W. DICKINSON & COMPANY, engineers, The Broadway, Bexley Heath, have taken offices at 130, Queen Victoria Street, E.C.

MR. C. R. WALKER, brassfounder, trading at Aston, Birmingham, as B. R. Walker, is paying a supplemental dividend of 2d. in the £.

ROWBOTHAM & COMPANY, of which Mr. J. C. Rowbotham is the sole partner, have removed to the Westholme Street Metal Works, Thornton Road, Bradford.

THE business of Peter Bell & Son, iron merchants, Pitt Street Ironworks, Edinburgh, has been acquired by Mr. J. S. Ross, engineer, 12, Humber Road, Blackheath, London, S.E.

MESSRS. NEWBY & SON, Phœnix Foundry, Loveday Street S., West Bromwich, will in future devote their attention to the manufacture of light cast-iron fittings for the electrical industry.

MESSRS. BRAITHWAITE & KIRK, Crown Bridge Works, West Bromwich, have taken into partnership Mr. Alexander Anderson—late a director of Edward Wood & Company, Limited, Manchester.

MESSRS. CAMPBELL, BINNIE, REID & COMPANY, of Hamilton, Lanarkshire, have just completed an addition to their Greenfield Foundry, which will enable the firm to materially increase their output.

MESSRS. J. H. FLITTON and J. J. HARGREAVES, carrying on business as general engineers at 4, New Cross Road, London, S.E., under the style of the Flitton Engineering Company, have dissolved partnership.

A NEW firm, under the style of the Muir-Davidson Steel Company has just been formed in New York, to act as general agents in the United States and Canada for Samuel Fox & Company, Limited, steel manufacturers, of Sheffield.

THE partnership heretofore subsisting between Messrs. A. W. Wilde, M. S. Wilde, and J. L. H. Slater, carrying on business as boiler makers and engineers, at Newton Moor, Hyde, under the style of James Wilde & Company, has been dissolved.

MR. PHILIP S. DOHERTY, engineer, of 25, Victoria Street, Westminster, London, S.W., notifies us that in consequence of the increase in his business he has taken into partnership Mr. W. Kelway Bamber, and will in future trade under the name of Doherty & Bamber.

THE limited partnership heretofore subsisting between Messrs. A. Marsden, of Middlesbrough, and H. D. Levick, of Middlesbrough, carrying on business as iron founders, etc., at Middlesbrough, under the style of Marsden & Company, has been dissolved.

A PAPER on "Nickel and Nickel Alloys" has been read by Mr. G. A. Boeddicker (Birmingham), vice-president of the Institute of Metals, before the members of the Sheffield Society of Applied Metallurgy, in the Lecture Theatre of the Applied Science Department of the University.

THE partnership heretofore subsisting between Messrs. E. Barker and G. H. Willson, carrying on business as machine-tool makers, at Forest Mills, Ovenden, Halifax, under the style of Smith, Barker & Willson, has been dissolved. Mr. G. H. Willson will continue to carry on the business on his own account under the same style.

W. RICHARDS & SONS, LIMITED, of the Britannia Foundry, Middlesbrough, have purchased the Atlas Works, adjoining their premises, which have been standing idle for six years. The firm intend starting the works as soon as the necessary plant can be put down. Messrs. Richards also propose to extend their bolt and rivet-making plant.

THE fifth annual meeting and dinner of the Staffordshire Metallurgical Old Boys' Association was held at Wednesbury on February 15. Mr. S. Holloway presided. The hon. secretary (Mr. F. S. Wilkinson) reported that the membership stood at 80, and there was a small balance in hand. The following officers were elected for the year:—President, Mr. F. S. Wilkinson; vice-president, Mr. Frank Castle; joint hon. secretaries, Mr. Arthur Palmer and Mr. F. S. Wilkinson.

THE works of the Leeds Engineering and Hydraulic Company, Limited, of Rodley, near Leeds, together with the tools, patterns and goodwill, have been purchased as a going concern by Mr. J. R. Pickering, a director of Clayton, Son & Company, Limited, also of Deighton's Patent Flue & Tube Company, Limited, and Mr. Alfred Towler, M.I.Mech.E., late of Hathorn, Davey & Company, Limited. They will continue manufacturing their predecessors' various specialities, and in addition all descriptions of power pumps.

A LARGE armour-plate bending press, which will have a power of 12,000 tons, is being constructed for Messrs. Cammell, Laird & Company's works at Sheffield by Davy Brothers, Limited, of the Park Ironworks, Sheffield, and a 90-ton casting for a portion of the base of the press has just been made. A 180-ton overhead travelling crane is also being erected at Grimesthorpe, to be used in the moulding department in place of a 120-ton crane. Further, an additional furnace is being put down for dealing with the largest forgings made, such as gun jackets, and extensions of the steel-making plant are being carried out.

A STATEMENT has been issued of the affairs of Joseph Sadler Stockton, of Beech House, Whiteley Wood, Sheffield. The debtor shows that the gross liabilities are £1,439, and there is a deficiency of £739. The cause of his failure was loss in the Carbrook Steel Works, Limited, of which he acted as managing director at a remuneration of £400 per annum. About the end of 1903, a receiver for the debenture holders took possession, and the debtor was then employed as manager, at the same salary. In December, 1903, the debtor entered into partnership with Mr. T. C. Clough, and they purchased the business carried on by the Carbrook Steel Works, Limited, from the receiver for the sum of £12,100, which was found by their bankers, to whom they gave a charge upon the whole of the assets. In 1909 the business was transferred to a limited company, the purchase money being fixed at £10,000. Accounts were taken, and, as a result, the debtor received 4,065 fully-paid preference and ordinary shares of £1 each, and Mr. Clough had the remainder. The debtor and Mr. Clough were appointed directors, at a remuneration of £400 per annum. In January, 1912, the debtor resigned from the company, and sold the whole of his holding therein for about £176.

THE affairs of Frank William Miller, 14, Devonshire Square, London, E.C., metal manufacturer, have come before Mr. Registrar Brougham at the London Bankruptcy Court, upon the hearing of his application for an order of discharge. Mr. W. G. Williams, Assistant Official Receiver, attended, and in reading his report said that so far as he was able to judge the total unsecured indebtedness amounted to £3,340. No assets were disclosed, and none had been or was likely to be received. The bankrupt was an American citizen, and came to this country in 1905 or 1906. He was employed in the metal trade until September, 1909, when he was associated with others in carrying on a metal business under the style of the Magnolia Metal Company of London until February, 1911. Then with a borrowed capital of £500 he began business under the style of the Magnolia Metal Company of England at 14, Devonshire Square, E.C. Owing to heavy initial expenses the business was, however, not profitable, and in July, 1911, he sold it to a limited company, which was afterwards converted into the Miller Anti-Friction Metal Company, Limited, of which he became the managing director. The Assistant Receiver opposed the application on the ground that the bankrupt's assets were not of a value equal to 10s. in the £; and that he had omitted to keep proper books of account. The Registrar imposed a suspension of the discharge for two years.

THE FIRST

# FOUNDRY TRADES' EXHIBITION

*Saturday, June 14th to Saturday, June 28th, 1913*

**ROYAL AGRICULTURAL HALL, ISLINGTON, N.**

*GENERAL MANAGERS:—*

FREDERIC W. BRIDGES - CHARLES H. LUKE, A.M.S.E.

Under Distinguished Patronage.

Makers of Foundry requisites of every description should take this opportunity of getting into direct touch with the Foundry Trades of Great Britain and other parts of the world.

The British Foundrymen's Association have arranged to hold their Annual Convention in 1913, in London, from the 20th to the 26th of June, when the above Exhibition will be open. The Association intends to officially visit the Exhibition on June 21st, when the members will be received by the Exhibition Authorities, supported by the various Committees who are assisting in the Organisation.

The Exhibition will be extensively advertised among Founders throughout Europe, and it is also the intention of the Managers to invite the whole of the members of the British, French and German Foundrymen's Association to visit the same.

The Royal Agricultural Hall is so well known as a venue for Commercial Exhibitions, that nothing need be said as to its suitability, whilst the advantage of holding the Exhibition during the Convention will be apparent, as this ensures the attendance of those interested in the various appliances shown.

It it has been decided to provide Season Tickets to all members of the British, French and German Foundrymen's Associations.

Plans and further particulars on application to

**The General Managers,**

**Foundry Trades' Exhibition,**

**124, Holborn, London, E.C.**

## Deaths.

Mr. R. T. Preston, a director of J. Stone & Company, Limited, engineers, of Deptford, London, S.E., has died at the age of 66 years.

The death is reported of Mr. R. H. Alderman, a partner in the firm of T. W. Palmer & Company, Merton Abbey Ironworks, Church Road, Merton, Surrey.

The death is announced of Mr. W. H. Shepherd, a director of Ramsden, Camm & Company, of the Robin Hood and Leopold Works, Brighouse, Yorks., at the age of 78 years.

The death is reported from Stockholm of M. de Laval, the famous engineer and inventor, at the age of 67. M. de Laval was one of the inventors of the steam turbine, having taken out his first patent in 1881.

The death is reported of Mr. Henry Pearson, who established the Beeston Foundry Company, Limited, of Beeston, near Nottingham, about five years ago. The deceased gentleman was, at the time of his death, on a trip to the East.

The death is announced from Vienna, at the age of 66 years, of Herr Karl Wittgenstein. The deceased was well known as one of the founders of the modern iron and steel industries in Austria, he having assisted in the starting of several important establishments.

The death has occurred at Basford, Stoke-on-Trent, of Major Alfred Bourne Jones, V.D., J.P. Major Jones, who was 68 years of age, was for many years the representative of the Shelton Iron, Steel and Coal Company, Limited, and was well known on the Exchanges at Birmingham, Liverpool and Cardiff.

The death has occurred of Mr. G. Matthey, of Cheyne House, Chelsea Embankment, in his 88th year. The deceased gentleman joined the firm founded by the late Mr. P. N. Johnson, now Johnson, Matthey & Company, Limited, assayers and refiners, Hatton Garden, at the age of 19. Within a few years he became a partner, and his active association with the firm continued until six or seven years ago.

The death has occurred suddenly of Mr. E. Drabble, J.P., of Wood Bank, Doncaster Road, Rotherham. The deceased gentleman was a director of the British Wagon Company, Limited, and was one of Rotherham's best known commercial men. He was the son of Rotherham parents, and for many years was actively engaged in the stove-grate industry, being one of the principals of the firm of Yates, Haywood & Drabble. He was 71 years of age.

We regret to record the death, which took place at Ayr on February 20, of Sir William Arrol, the eminent engineer, and chairman of the firm of Sir William Arrol & Company, Limited, of the Dalmarnock Ironworks, Bridgeton, Glasgow. He was born in 1839. Reference is made on another page to the career of Sir William Arrol.

## Personal.

Sir Hugh and Lady Bell have sailed for the Cape in the "Kinfauns Castle."

The late Mr. William Petley, ironfounder, of Stourbridge, has left estate valued at £9,003 gross.

The late Mr. William Henry Hacking, ironfounder, of Bury, Lancashire, left estate valued at £106,528.

The late Mr. R. H. Measures, of Measures Bros., Limited, left estate valued at £1,071 gross, with net personalty nil.

The late Mr. E. A. Hooper, managing director of Edgar A. J. Hooper, Limited, left estate of the gross value of £5,837, of which £4,092 is net personalty.

The late Mr. W. C. Parkinson, chairman of Parkinson & W. & B. Cowan, Limited, left estate valued at £294,474 gross, with net personalty £289,149.

Colonel Armstrong has retired from the board of William Beardmore & Company, Limited, and Colonel Smith-Park has been elected as director in his place.

The late Mr. T. Bamforth, general manager of the Carron Company, Limited, left, in addition to real estate, personal estate in the United Kingdom valued at £8,049.

The late Mr. H. I. Dixon, a director of the Cleveland Bridge and Engineering Company, Limited, left estate of the gross value of £91,262, with net personalty £60,423.

Mr. R. E. Carr has been elected a director of the Bede Metal and Chemical Company, Limited. For many years Mr. Carr had charge of the Company's business in Spain.

The gross value of the estate of the late Mr. T. W. Robinson, of Thomas W. Robinson, Limited, of the Dennis Park Ironworks, Stourbridge, is £26,061, with net personalty £20,471.

Mr. J. Kemp-Welch has been transferred from the Peterborough works of Peter Brotherhood, Limited, to take charge of their London office at 53, Parliament Street, Westminster, S.W.

Mr. S. J. Wavish, at present manager at the Newcastle works of Sir W. G. Armstrong, Whitworth & Company, Limited, is to succeed Mr. William Boyd at the works of Cammell, Laird & Company, Limited.

Mr. W. H. Thomas, director and general manager of William Jessop & Sons, Limited, Brightside Steelworks, Sheffield, has been elected managing director jointly with Mr. Sydney Jessop Robinson, who has filled this position for many years.

Mr. James Jones, nail manufacturer and ironfounder, Larbert, has been publicly entertained and presented with an illuminated address in recognition of his long public services to the district. Mr. George Pate, of the Carron Company, made the presentation.


# A REVOLUTION IN THE FOUNDRY.

## THERE IS NOTHING LIKE IT.

Proved by the leading firms to be absolutely reliable and holds an impregnable position in the foundry after all others have failed

**"SPERMOLIN"** (Regd).

Is used by all the leading firms in the making of Cores of Castings for Steam Engines, Turbines, Gas and Oil Engines, Motor Car Cylinders, Pumps of all descriptions, Machine Tools, Radiators, Sectional Boilers, Gas Stoves and Gas Rings, Malleable Iron Castings, Steel, Iron and Aluminium Castings.

*FOR FURTHER PARTICULARS WRITE TO:—*

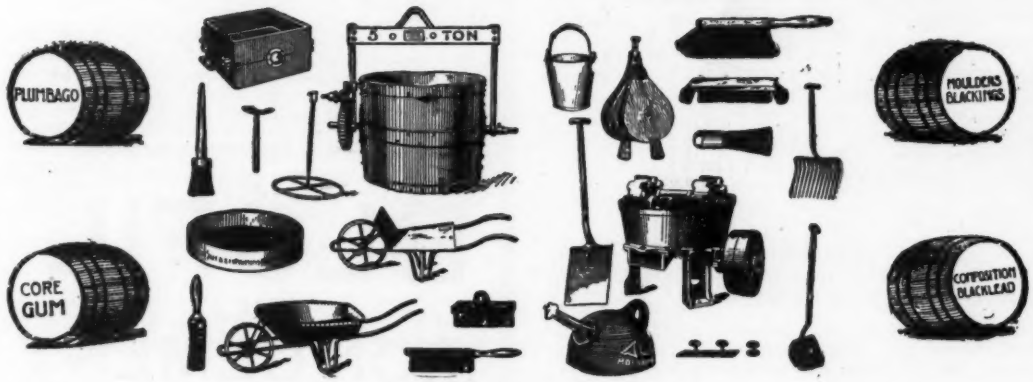
**The SPERMOLIN Core Co., George Square, HALIFAX.**

Or to:— **HALL AND GILLAM, EXCHANGE BUILDINGS, BIRMINGHAM.**

*Established 1863.*

# JAS. DURRANS & SONS,

## Phœnix Works, Penistone, Near Sheffield.



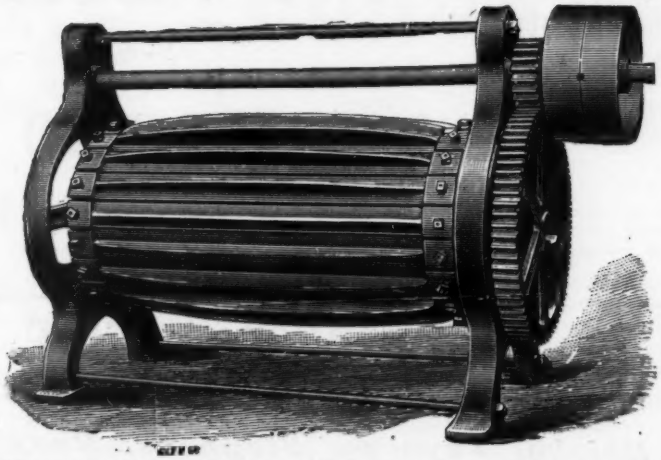

**Manufacturers of all**

## *FOUNDRY EQUIPMENTS*

**COMPOSITION BLACK LEAD, PLUMBAGO, CORE GUM, WHITE DUST & COAL DUST**

**Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux. Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.**

## Improved Foundry Rattler or Fettling Drum.



**These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.**

The following testimonial explains itself :—

"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD.

## PRICES OF METALS.

The following table shows the approximate latest prices and position of stocks of metals during the past two years:—

| Metals. | End Feb., 1913. | End Feb., 1912. |
|---|---|---|
| Iron—Scotch pig warrants ton | *67/7½ | *55/6 |
| —Middlesbro' warrants .. ton | 61 5½ | 49 7½ |
| —W.C. M/nos Bessemer ... ton | 86 0 | 67 0 |
| —Stock, Middlesbrough ...tons | 221,550 | 515,306 |
| Copper—Chili bars GMB ton | £65 5 0 | £61 5 0 |
| —Stock, Europe and afloat tons | — | — |
| Tin—English ingots ... ton | £223 0 0 | £199 0 0 |
| —Straits ... ... ... ton | £215 15 0 | £192 15 0 |
| —Stock, London, Holland, U.S.A., and afloat ...tons | — | — |
| Lead—English pig ... ton | £16 15 0 | £16 3 9 |
| Spelter—Ord. Silesian ... ton | £25 0 0 | £26 12 6 |
| Quicksilver (75lb)... bottle | £7 15 0 | £8 7 6 |
| Antimony—Regulus ... ton | £36 0 0 £37 0 0 | £27 10 0 £28 0 0 |
| Aluminium—Ingot ... ton | £88 0 0 | — |

*Settlement pric.

### Castings.

In the Cleveland district the following are the nominal rates current for castings:—

| | £ s. d. | £ s. d. |
|---|---|---|
| Columns (plain) ... ... ... ... | 7 7 6 to | 7 12 6 |
| Pipes, 1¼ to 2½ in. ... ... ... ... | 6 12 6 to | 7 0 0 |
| ,, 3 to 4 in. ... ... ... ... | 6 5 0 to | 6 7 6 |
| ,, 5 to 8 in. ... ... ... ... | 6 0 0 to | 6 2 6 |
| ,, 10 to 16 in. ... ... ... ... | 6 2 6 to | — |
| ,, 18 to 24 in. ... ... ... ... | 6 2 6 to | — |
| Chairs ... ... ... ... ... ... | 4 14 0 to | 4 15 0 |
| Floor plates (open sand) ... ... ... | 3 10 0 to | 3 12 6 |

### Scrap.

The quotations for scrap, subject to market fluctuations, are as follows: Heavy wrought (mixed), £2 17s. 6d.; light wrought, £1 5s. 0d.; heavy cast, £3 3s. 6d.; all per ton, f.o.b., London. Copper (clean), £59 10s. 0d.; brass (clean), £42 10s. 0d.; lead (usual draft), £15 5s. 0d.; Zinc, £19 5s. 0d.; all per ton delivered merchant's yards.

## Inventions.

### Applications for Patents.

An asterisk indicates that a complete specification accompanies the application. When inventions are communicated the names of the communicators are in brackets.

1,819. Metal alloy. C. E. Monkhouse and M. H. Denton.

2,103.*Pattern moulding machines. Vereinigte Schmirgel und Maschinen Fabriken Act.-Ges., vorm. S. Oppenheim & Company, und Schlesinger & Company.

2,289.*Cupola furnaces. P. Anderson.

2,484.*Thermal treatment of steel ingots and castings. (Soc. Anon. Italiana Gio. Ansaldo & Company, Italy).

2,487.*Metal alloy. E. Haynes.

2,489.*Furnaces for metallurgical purposes. J. A. Hill.

2,577.*Electric furnace with electrodes running through the receptacle for the charge, and means in the upper part for carrying off the gases. A. Helfenstein.

2,718. Electric furnaces. F. C. Wardall and J. Marchant.

The discharge from bankruptcy of Mr. H. A. Simmonds, brassfounder, trading as F. H. Simmonds, 22 and 24, New Charles Street, Goswell Road, London, E.C., and 43, Hall Street, City Road, London, E.C., has been suspended for two years.


BLOFIL

THE

IRON CEMENT

(Quick or slow setting grades)

IS

THE CHEAPEST

AND

MOST RELIABLE

for all purposes.

*Unaffected by oil, steam, or water.*

Sole manufacturers—

RUDD & OWEN (DEPT. I)

Telegrams "Theripnene," Hull.

HULL

Telephone National, 1223.

GANISTER, CUPOLA BLOCKS, FIRE BRICKS,

FIRE CLAY.

*Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.*

STEEL MOULDERS' COMPOSITION, SILICA CEMENT.

J. GRAYSON LOWOOD & Co., Ltd.,

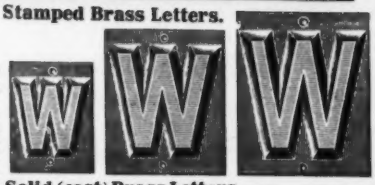
DEEPCAR, nr. SHEFFIELD.

Telegrams: "LOWOOD, DEEPCAR."

WHITE METAL LETTERS

Stamped Brass Letters.

All kinds of Letters for Pattern-making and Foundries supplied from stock at very advantageous prices.



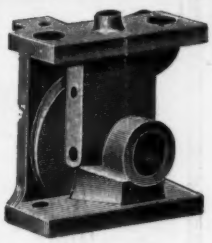
Solid (cast) Brass Letters.

**Walton & Co.,**

Newton Street,

**Birmingham.**

**YOU CAN CUT DOWN COSTS ON COMPLICATED SMALL PARTS**



¶ To obtain such a part as that illustrated above by ordinary methods of casting would entail an amount of time and money out of all proportion to the profit you should make on in

¶ Why not secure the extra profit and the certainty of scientific precision hat is offered you by using - -

**"Prana" Die-Finished Castings?**

**Holes, Slots, Teeth, Notches, Screw Threads, etc., are accurately cast — no machining. Send for Booklet F., mentioning this paper, to**

**AERATORS LIMITED**

**EDMONTON, LONDON, N.**

**ELDERS FOUNDRY COKE**

**AS SUPPLIED TO THE BRITISH ADMIRALTY DOCKYARDS.**

**The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.**

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time.
We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, more free from blowholes and other defects, than we formerly did.

From BOW, McLACHLAN & CO., LTD. (Paisley Foundry), Paisley, Glasgow.

Paisley, 12th March, 1909.

We have yours of 4th inst., and in reply have pleasure in stating that we have been using your Foundry Coke for several years for special purposes with highly satisfactory results.

**Elders Collieries, Ltd., Cardiff.**

# The "Tottenham" Portable Hot-Air Core Oven.

The Oven is built on a Scientific principle which causes a rapid circulation of hot dry air to pass round the cores. They are dried thoroughly right through; those on the top shelf being dried as quickly as those below. Burning the cores is impossible, as no flame or smoke comes into contact with them.

It is arranged for fuel or gas and is exceedingly economical in the consumption of either.

Call and see it.

THE "BUESS" OIL-FIRED CRUCIBLE MELTING FURNACE IS WITHOUT A RIVAL. THERE IS NO OTHER TO COMPARE WITH IT FOR ECONOMICAL WORKING AND SIMPLICITY OF OPERATION.

**With our 15 different Types of Moulding Machines we cover the requirements of any foundry, call and see them at work.**

**EMERY GRINDERS. ABRASIVE WHEELS.**

## THE LONDON EMERY WORKS Co., PARK WORKS,

**TOTTENHAM, LONDON, N.**

**Passenger Station, Park, G.E. Rly.** **Telephone: Tottenham, 158**

# THE BUYER'S GUIDE

*Addresses and further information will be found by reference to the Firm's Advertisement.*

**Abrasive Wheels.**
Evans, J. & Co.
London Emery Works.
Jackman, J. W., & Co

**Air Compressors.**
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.
Thwaites Bros., Ltd.
Tilghman's Patent Sand Blast Co., Ltd.

**Air Compressors (Electrically Driven).**
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Tilghman's Patent Sand Blast Co., Ltd.

**Air Compressors(Steam).**
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Tilghman's Patent Sand Blast Co., Ltd.

**Air Compressors (Belt).**
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Tilghman's Patent Sand Blast Co., Ltd.

**Aluminium.**
British Aluminium Co., Ltd.

**Annealing.**
Evans, J., & Co.
Phillips, J. W. & C. J.

**Ash Crushing and Washing Machines.**
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

**Barrels (Tumbling).**
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Hall, Charles, & Co.
Hooker, Peter, Ltd
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall, H. P., & Co.
Phillips, J. W. & C. J.
Standard Sand-Blast Machine Co., Ltd.
Tilghman's Patent Sand Blast Co., Ltd.

**Barrows.**
F. Braby & Co , Ltd
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.

**Bellows.**
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Durrans, Jas., & Sons.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.

**Blacklead.**
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.
Walker, I. & I.
Wilkinson & Co., Thos., Ltd.

**Blowers.**
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davis, T., & Son.
Dempster, R. & J., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Keith, J., & Blackman Co.,Ld.
London Emery Works Co.

**Blowers**—*cont.*
Marscall, H. P., & Co., Ltd.
Phillips, J. W. & C. J.
Samuelson & Co., Ltd.
Thwaites Bros., Ltd.

**Buffing and Polishing Machines.**
Jackman, J. W., & Co., Ltd.
London Emery Works Co.

**Casting Cleaners.**
Durrans, J., & Sons.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Tilghman's Patent Sand Blast Co., Ltd.

**Castings.**
Aerators, Ltd.

**Cement.**
Dyson, J. & J.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Lowood. J. Grayson, & Co., Ld.
Marshall & Co., Horace P.
Metalline Cement Co.
Olsen, Wm.
Plasti-Kion Co.
Rudd & Owen.
Silent Machine and Eng. Co.

**Chaplets and Studs.**
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Motherwell, Wm., & Co.
Olsen, Wm.
Wilkinson, T., & Co., Ltd.

**Charcoal.**
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
Mansergh, T. E.
Walker, I. & I.

**Charging Platforms.**
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davies, T., & Son.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Thwaites Bros., Ltd.

**Coal Dust.**
Cumming, Wm., & Co., Ltd.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
Mansergh, T. E.
Olsen, Wm.
Walker, I. & I.
Wilkinson & Co., Thos., Ltd.

**Coke (Foundry).**
Elders Navigation Collieries.

**Coke Breakers.**
Evans, J., & Co.
Jackman, J. W., & Co., Ltd
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

**Core Boxes.**
Evans, J., & Co.
Jackman J. W., & Co., Ltd.
Olsen, Wm.

**Core Compounds.**
Cumming, Wm., & Co., Ltd.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.
Wilkinson Thos., & Co.

**Core Gums.**
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.
Walker, I. & I.
Wilkinson & Co., Thos., Ltd.

**Core Making Machines.**
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall, H. P., & Co.
Phillips, J. W. & C. J.

**Core Ovens.**
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Hislop, R. & G.
Jackman, J. W. & Co., Ltd.
Jones & Attwood, Ltd.
London Emery Works Co.
Phillips, J. W. & C. J.

**Core Ropes.**
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.
Wilkinson, T., & Co.

**Core Vents.**
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.

**Cranes.**
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Ward, T. W., Ltd.

**Crucibles.**
Evans, J., & Co.
Hall, Charles, & Co.
Olsen, Wm.

**Crucible Furnaces.**
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.

**Crucible Furnaces (Lift-out).**
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Phillips, J. W. & C. J.

**Crucible Furnaces (Tilting).**
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

**Crushing Mills.**
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Jackman, J. W., & Co., Ltd.

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Alldays & Onions Pneumatic Eng. Co., Ltd.
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Derby Boiler Co., Ltd.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall, H. P., & Co.
Phillips, J. W. & C. J.
Thwaites Bros., Ltd.

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Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.

**Emery Grinders.**
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Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co

**Emery and Glass Clot and Glass Paper.**
London Emery Works Co.

**Emery Wheels.**
Alldays & Onions Pneumatic Eng. Co., Ltd.
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Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Mitchells Emery Wheel Co.

**Facings.**
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Olsen, Wm.

**Fans.**
Alldays & Onions Pneumatic Eng. Co , Ltd.
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Jenkins, W. J., & Co , Ltd.
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King Bros.
Lowood, J Grayson, & Co., Ld.
Pearson, E. J. & J

**Foundry Blacking.**
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Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Olsen, Wm.
Walker, I. & I.
Wilkinson, Thos., & Co., Ltd.

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Durrans, J., & Sons.
Evans, J., & Co.
Hall, C., & Co.
Jackman, J.W., & Co., Ltd.
Olsen, Wm.
Phillips, J. W. & C. J.

**Foundry Ladles.**
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davies, T., & Son.
Derby Boiler Co., Ltd.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall, H. P., & Co.
McNeil, Chas.
Phillips, J. W. & C. J.
Thwaites Bros., Ltd.

## THE BUYERS' GUIDE.—*Continued.*

**Foundry Rattlers or Fettling Drums.**
Alldays & Onions.
Davies, T., & Son.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co.
London Emery Works Co.
Marshall & Co., Horace.
Phillips, J. W. & C. J.

**Foundry Sand.**
Standard Sand Co., Ltd.
Dyson, J. & J.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Wilkinson, & Co., Thos., Ltd.

**Foundry Specialists.**
Naish & Croft.

**Furnaces (Annealing).**
Alldays & Onions Pneumatic Eng. Co., Ltd.
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Hislop, R. & G.
Keith, James, & Blackman, Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

**Furnaces (Brass).**
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

**Furnaces (Melting).**
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davies, T., & Son.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

**Ground Gannister.**
Durrans, J., & Sons.
Dyson, J. & J.
Evans, J., & Co.
Lowood, J. Grayson, & Co.
Walker, I. & I.

**Grinding Machines and Tools.**
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.

**Hammers (Steam).**
Alldays & Onions Pneumatic Eng. Co., Ltd.
Thwaites Bros., Ltd.

**Hay Band Spinning Machines.**
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.

**Hoists.**
Alldays & Onions Pneumatic Eng. Co., Ltd.
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Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall, H. P., & Co., Ltd.
Phillips, J. W. & C. J.
Thwaites Bros., Ltd.

**Loam and Sand Mills.**
Davies, T., & Son.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall & Co., Horace P.

**Magnetic Separators.**
The Rapid Magnetting Machine Co., Ltd.

**Melting Furnaces (Oil Fired).**
Alldays & Onions Pneumatic Eng. Co , Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

**Mould Driers.**
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

**Moulding Machines.**
Adjustable Moulding Machine Co.
Britannia Foundry Co.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall, H. P., & Co.
Phillips, J. W. & C. J.
Pneumatic Engineering Appliances Co., Ltd.
Samuelson & Co., Ltd.
Stewart, Duncan & Co., Ltd.
Universal System of Machine Moulding and Machinery Co., Ltd.
Whittaker, Wm., & Sons, Ltd.

**Moulding Machines (Hand and Power).**
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

**Pig Breakers.**
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.

**Pig-Iron.**
Bradley & Sons, T. & I., Ltd.
Frodair Iron and Steel Co., Ltd., The
Goldendale Iron Co., Ltd.

**Plumbago.**
Cumming, Wm., & Co., Ltd.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Olsen, Wm.
Walker, I. & I.
Wilkinson & Co., Thos., Ltd.

**Pneumatic Tools.**
Jackman, J. W., & Co., Ltd.
J. Macdonald & Son, Ltd.
Marshall, H. P., & Co.

**Polishing Sundries.**
Evans, J., & Co.
London Emery Works Co.

**Publications.**
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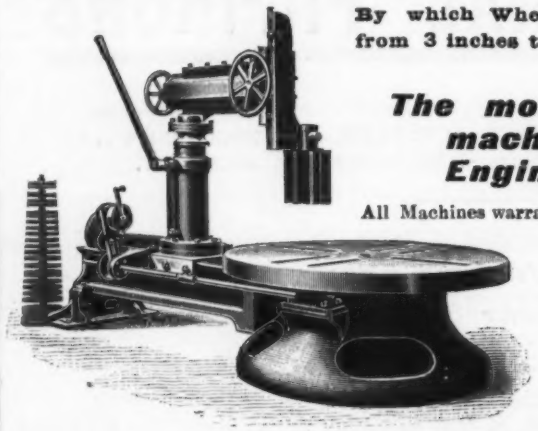

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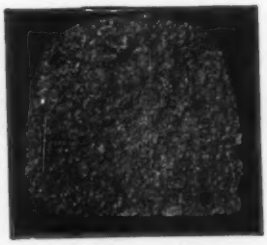
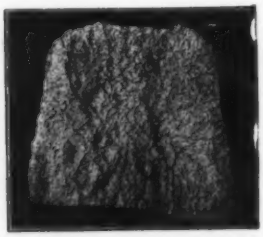

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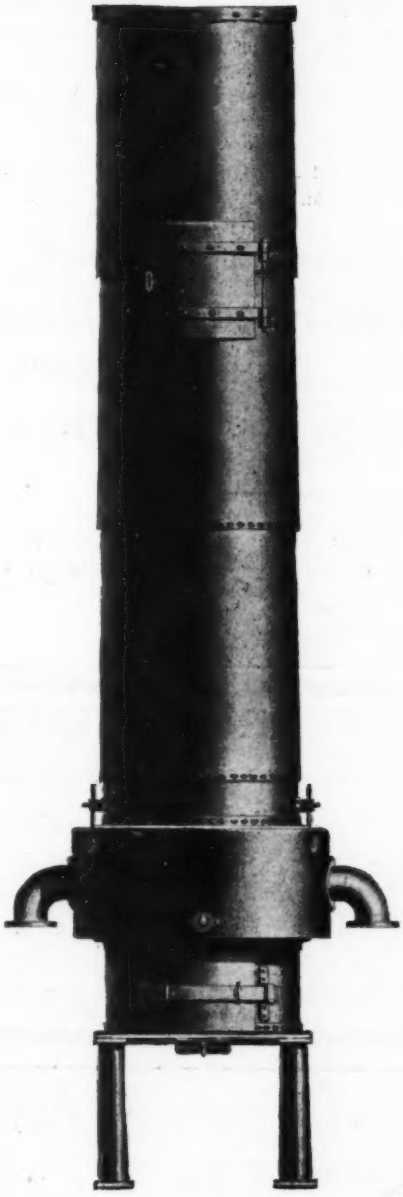

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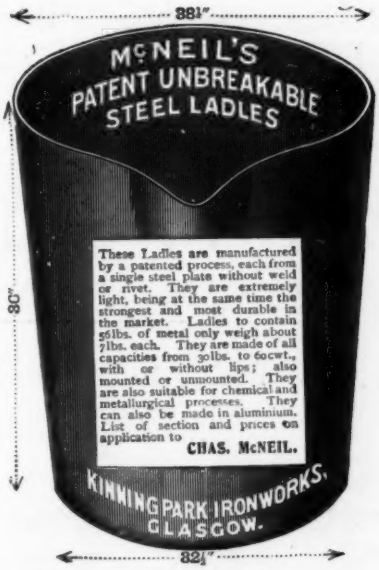
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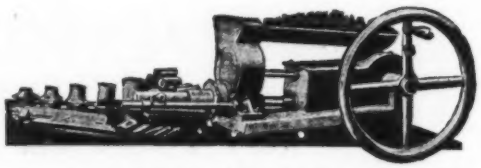

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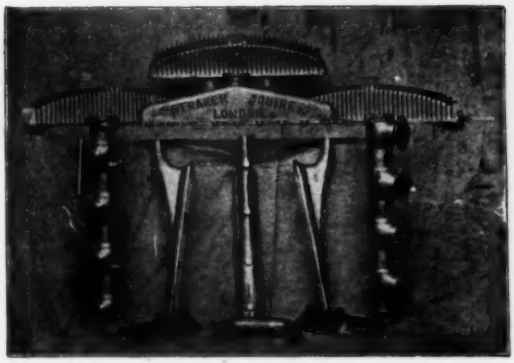

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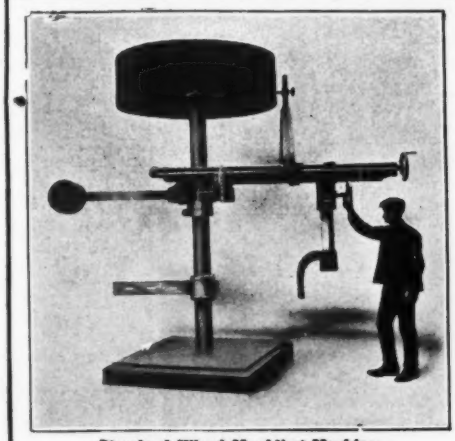

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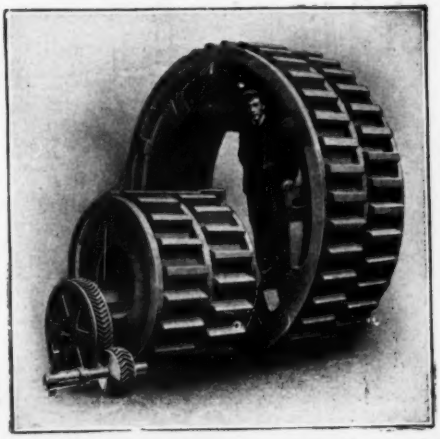

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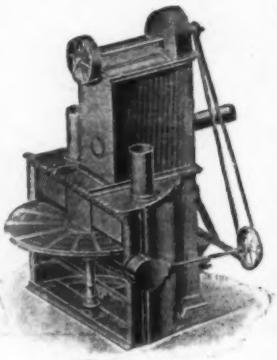

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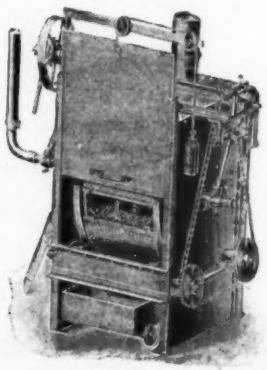

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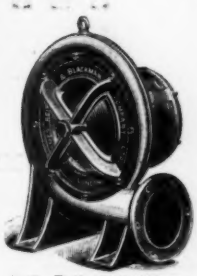
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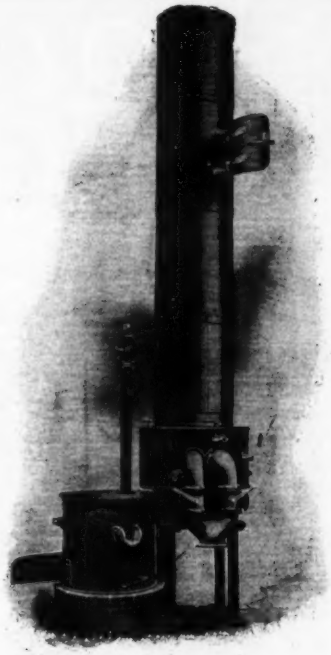

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